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ABSTRACT

A study examined whether pictures presented in advance of reading a text (advance organizers) as compared to pictures presented after reading a text (postorganizers) would significantly enhance the reader's retention of the text's content. Sixty college students rated their familiarity with six topics, then read materials presented on the three topics with which they were least familiar. The presentation was in one of the following conditions: pictures before text (DT), pictures after text (TD), pictures simultaneously with text (ST), the same picture twice (DD), and the same text twice (TT). Free recall and short answer criterion measures were used to assess comprehension. Contrary to hypotheses, the only factor to affect the number of correct responses significantly and positively was the material presented second. In particular, when text followed an earlier presentation of diagram or text (DT or TT), scores on the free recall and short answer tests were significantly higher than when a diagram followed an earlier presentation of diagram or text. The order of experimental conditions, from most to fewest correct responses, was TT, ST, DT, TD, and DD. There was also greater recall/comprehension for the first story that was read in the sequence of three and for the story ranked most familiar of the three stories read. (RL)

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The Pennsylvania State University
Program in Educational Psychology,
Division of Counseling and Educational Psychology

The Effects of Diagrams-Before Text vs.
Diagrams-After Text in the Processing
of Novel Text Information

A Thesis in
Educational Psychology

by

Stephen T. Peverly

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

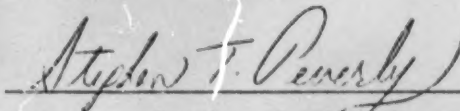
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CHAPTER I

INTRODUCTION

Can adjunct materials facilitate the comprehension and recall of text materials? In one form or another, this question has generated voluminous amounts of educational research and theorizing. Some points of view are represented in the following: Ausubel (1967, 1968) has based his theory on the assumption that an "organizer" presented in advance of text materials would facilitate the incorporation (subsumption) of that material into the learners' existing cognitive structures. Rothkopf (1966) has hypothesized and provided evidence that questions placed in various relationships to text material (e.g., questions after text) might enhance both the formation of appropriate search behaviors and the comprehension of text. Others have demonstrated (e.g., Levin & Lesgold, 1978) that pictures accompanying text materials can have a positive effect on the learning of textual information.

Backgrounds of the Related Areas of Research

The backgrounds of the three research areas that have employed the before and after paradigm, or pictures in conjunction with text, are explicated in the following discussions.

Advance Organizers

Ausubel (1967, 1968) argues that meaningful learning must consider both the nature of the learning materials and the information

contained in the learners' current cognitive structures. This information must not only be relevant to the critical learning situation but must also be clear, stable, organized, and differentiated. The learning materials must be capable of relating to this structure in both a nonarbitrary (nonrandom material capable of relating to existing cognitive structures) and substantive manner (an equivalent group of symbols could be similarly related to the same relevant cognitive structures with no change in meaning). The learner can then use the organization of existing concepts to assimilate the new knowledge (1967, p. 20), which will then serve to protect its identifiability and to guard it from interference. Concurrently, existing knowledge is further differentiated, i.e., it is expanded and made more precise (progressive differentiation), by changes in structure and meaning through the "reconciliation" of differences and similarities between incoming information and current cognitive structure (integrative reconciliation).

Ausubel hypothesizes that new learning can be promoted through the use of relevant introductory materials or organizers (i.e., advance organizers). These are usually introduced prior to the presentation of the material to be learned, so as to facilitate the anchoring of this information to the learners' knowledge structures. To be successful with a variety of learners, "organizers are presented at a higher level of abstraction, generality and inclusiveness than the material to be learned" (Ausubel, Novak, & Hanesian, 1978, p. 171). Mayer (1979) is more specific. An advance organizer has each of the following properties:

(1) a short set of verbal or visual information, (2) presented prior to learning a larger body of to be learned information, (3) containing no specific content from the to be learned information, (4) providing a means of generating the logical relationships among the elements in the to be learned information, and (5) influencing the learners' encoding process. (p. 382)

Both Ausubel's (e.g., 1960) and Mayer's (e.g., 1979) conceptualizations imply that the content and the logical organization of the content of advance organizers act as priming mechanisms, facilitating the accessibility of hierarchically organized and differentiated knowledge structures relevant to the information that is targeted to be learned. Once this cognitive information is made more accessible, the probability is increased that the new information will be maximally integrated into this structure. This will lead to broader and more stable learning outcomes, more so, than if the advance organizers had not been present.

Though there are potentially hundreds of types of advance organizers, Ausubel (1968) talks about two. Expository organizers are used when the material to be presented is unfamiliar to the learner. It attempts to anchor the information to what the learner already knows, only in a most general fashion. If the material is familiar to the learner, comparative organizers are used to explicitly point out the similarities and differences among relevant ideas. They are also used in attempts to increase the discriminability between the two distinct, yet possibly confusable, sources of information.

Adjunct Questions

The current wave of research on adjunct questions was initiated within a neobehavioristic framework by Rothkopf (1965). It generally

dealt with verbatim level questions requiring literal recall of specific information in the associated text passage. In the main, these studies were concerned with the effect of manipulating certain variables, such as question position, frequency and mode on the retention of intentional and incidental information. (Rickards & Denner, 1978, p. 319)

Because such research is often atheoretical, some have referred to this approach as "variables research" (Rickards & Denner, 1978) or "dustbowl empiricism" (Di Vesta, 1975). In Rothkopf's view, questions not only facilitate the acquisition of content but the acquisition of "inspection behaviors" that are consistent with the training objectives.

There has been, however, a refinement of this notion of the effect of questions on the processing of text, dependent upon the variable involved (e.g., the position of questions, type of questions, etc.). The one variable most germane to this thesis is the position of questions, either pre or post. Though there are exceptions to the trend to be mentioned subsequently and differing theoretical explanations of it (i.e., cognitive or behavioristic), there does seem to be some consensus that prequestions will focus the learner's attention to certain parts of the text and encourage the retention of only those aspects. Postquestions, on the other hand, will effect a more extensive conceptualization of material, leading to broader and more integrated learning outcomes.

Pictures with Prose

Early studies on the effects of pictures on learning focused on such simple relationships as pictures and text versus text alone (Miller, 1938), illustrated versus nonillustrated text versus graphs and text (Vernon, 1953), or pictures versus black and white drawings

versus no pictures (all in association with text) (Vernon, 1954) to determine if the presence of these materials might have any effect on comprehension. The studies have been conducted within the framework of the hypothesis of no difference and the results most usually have been presented relative to the presence or absence of the hypothesized outcomes without the interjection of noticeable theoretical biases (as might be found in Rothkopf, 1966).

Later studies, however, have reflected a somewhat different perspective, most generally involving more sophisticated questions and more complex methodologies. Rohwer and Harris (1975) investigated the interactive effects of factors such as socioeconomic status, presentation media, test-item structure, and response methods on comprehension. Another study examined the effects of contradictory versus no contradictory information between pictures and text on the sources of information utilized by the participants in responding to multiple-choice questions (Peeck, 1974). Others (e.g., Haring & Fry, 1979) have been concerned with the interaction of pictures (and levels of detail) and text structure (i.e., the main idea versus lower level details) on the retention of information.

Interpretations of the interactions of pictures and verbal materials have focused on context (Bransford & Johnson, 1972), depth of processing (e.g., Nelson & Reed, 1976), and unimodal versus multimodal encoding systems (e.g., D'Agostino, O'Neill, & Paivio, 1977; Odom & Nesbitt, 1974). Research on pictorial schemata is also cited (Mandler & Ritchey, 1977) with emphasis on the content of schemata and not the encoding of information.

Statement of the Problem

The primary concern was whether pictures presented in advance of text (i.e., advance organizer) as compared to pictures presented after text (i.e., postorganizer) would significantly enhance the retention of its content. The design necessary to answer this question required the following considerations (see, e.g., Levin & Lesgold, 1978): pictures before text, pictures after text, pictures presented simultaneously with the text, the same picture viewed twice, and the same text viewed twice. Another question was whether parallels can be drawn between the results of this experiment and the results presented by those researchers who have assessed the effects of pictures on the comprehension of prose (e.g., Bransford & Johnson, 1972; Rohwer & Harris, 1975).

Before describing the procedures and results in detail, the relevant literature will be reviewed. Three basic areas will be covered: the efficacy of advance organizers in promoting meaningful learning, prequestions and postquestions as they affect the learning of prose, and the effect of pictures on the comprehension of text materials and learning to read.

CHAPTER II

REVIEW OF THE LITERATURE

Educational psychologists have long been concerned with discovering "the variable" or set of variables that will positively and consistently influence learning outcomes beyond those which might ordinarily be considered in the classroom. One relatively recent orientation of this concern has been the effects of adjunct materials (nonessential information that might be helpful in understanding text information) or amalgams (information that is absolutely essential to the understanding of the text) on the comprehension of written information. Though there are many different types of these, this chapter will focus on but three: advance organizers, inserted questions, and pictures. The first two developed from very definite theoretical positions (cognition and neobehaviorism, respectively). Pictures research, on the other hand, initially developed within an atheoretical framework, though this has changed noticeably in recent years. The other two research areas have also expanded and have been modified over time in terms of the questions that have been asked and the refinement of theoretical positions. These notions will be developed in the remaining paragraphs of this chapter.

Organizer Research

Ausubel's (1960) original study was based on the assumptions that cognitive structure is hierarchically organized from superordinate to

subordinate concepts and that new material can become integrated within this hierarchy when relevant concepts are available to act as subsumers. He sought to test these assumptions by deliberately introducing relevant subsuming concepts (advance organizers) to determine whether learning and retention could be facilitated. Ausubel's (1960) initial test of these assumptions and those that follow it are presented below.

A General Test of the Paradigm

The postulations that were stated in the foregoing paragraphs were put to a series of tests (Ausubel, 1960; Ausubel & Fitzgerald, 1961; Ausubel & Fitzgerald, 1962; Ausubel & Youssef, 1963), where expository and/or comparative advance organizers were compared to historical, biographical, and other types of introductory passages (hypothesized not to have any organizational properties) to determine their facilitative effects on the retention of text material.

Ausubel (1960) found initially that an expository organizer facilitated the retention and recall of information beyond that of the control group. Subsequent studies, however, were not so conclusive. The observed effects of advance organizers were found to be influenced by time of testing (3 days or 10 days after treatment) (Ausubel & Fitzgerald, 1961), ability level (Ausubel & Fitzgerald, 1962; Ausubel & Youssef, 1963), levels of prior knowledge (Ausubel & Fitzgerald, 1961; Ausubel & Youssef, 1963), and whether there was just one passage or two passages presented in series (Ausubel & Fitzgerald, 1962). Since then, other tests of this general transfer paradigm have appeared in the literature, but with similarly mixed results. On the positive side, advance organizers were found to facilitate the comprehension of

mathematical groups among college education majors (Scandura & Wells, 1967), to aid the understanding of geography concepts among ninth graders (Allen, 1970), and to facilitate the assimilation of the theory of the continental drift by eighth-grade science students (Weisburg, 1970). Interestingly, the latter study utilized visual pictorial organizers, a type similar to the ones employed in this thesis, as compared to an expository text (i.e., verbal) organizer and a no-organizer control group. Only the visual advance organizers were found to be significantly and positively different from the no-organizer group.

In other studies, however, advance organizers have not been found to facilitate the learning of meaningful information. Livingston (1970) conducted three experiments, two with eighth-grade classes and one with a high school class, utilizing the same experimental procedures. There were no differences between any of the experimental groups and the control groups. Studies by Sowder et al. (1973) and Barron (1971) also produced no significant results. The outcomes of the latter contrast those of Weisburg (1970). Here too, graphic, text, and no-organizer treatments were compared across grade levels, rather than within a grade level as in the Weisburg study (1970). No significant differences were found.

Transfer of Information

Ausubel has not generated any specific hypotheses about either the transferability of individual cognitive structures or the ability of advance organizers to facilitate the transfer of information other than to say that they

Undoubtedly facilitate the learning of factual material more than they do the learning of abstract material, since abstractions, in a sense, contain their own built-in organizers--both for themselves and for related detailed items It would, therefore, seem especially advisable to use organizers with learning material that embraces a substantial body of differentiated or factual content, for such materials offer maximum scope for the ideational scaffolding provided by abstract organizers. (Ausubel, Novak, & Hanesian, 1978, p. 172)

Mayer has conducted an ambitious research program to evaluate whether organizers have specific facilitating effects on meaningful learning with particular emphasis on transfer. His studies have been generated from, and interpreted within, the framework of his Assimilation Encoding Theory, a three-stage model of encoding processes. Basically, the individual receives information from the outside world (Stage I), ascertains whether there are relevant anchoring concepts contained in long-term memory (Stage II), and transfers the possible subsumers into working memory so that they can be actively integrated with the incoming information (Stage III). The main predictions of this theory are:

(1) conceptual anchoring--the idea that fundamental conceptual ideas from the text will be integrated with existing knowledge and thus lead to better transfer, (2) obliterative subsumption--the idea that minor details and technical facts may be lost in the assimilation process, and (3) that giving the organizer before learning may result in facilitation of factors b (Stage II) and c (Stage III) and thus a broader learning outcome. (Mayer, 1979, pp. 373 and 375)

The thrust of Mayer's transfer studies have focused on near (test items are very similar to the information in the experimental materials) and far (test items are very different from the experimental materials) transfer. A series of experiments (Mayer, 1975) evaluated the ability of nonprogrammers to learn a computer programming language by either a model (i.e., an advance organizer) or nonmodel

approach. Though both groups read the same introductory materials, the text of the model group began with a model of the computer with each of the programming statements illustrated with respect to that model. The results of the posttest indicated that the experimental group excelled on the far transfer items (e.g., interpretations of programs), while the nonmodel participants excelled on near transfer items (e.g., straightforward generation of programs).

A possible criticism of Mayer's set of experiments (as suggested by Mayer, 1979) was that the reported transfer effects were the result of the greater amounts of information given to the organizer group. To investigate this question, Mayer (1976) conducted a series of studies which were very similar to the 1975 study, with the exception that the same organizer was given either before or after the text on computer programming. The assumption was:

That a broader encoding of new information allowing broader transfer would result only if the model was available and activated as a learning set during learning. If presented after learning, we predict the concrete model might serve to help retrieve past learning from LTM but could not make past learning "meaningful." (p. 143)

As before, the advance organizer group excelled on tasks of far transfer, while the after group performed similarly to the group that received no organizer at all, i.e., they excelled on tasks of near transfer.

In another series of experiments, Mayer, Stiehl, and Greeno (1977) hypothesized that an advance organizer which emphasizes concepts should lead to superior transfer while an organizer which involves the presentation of a formula should lead to superior retention. To test these hypotheses, a group of participants learned to solve multistep

probability algorithms by the method of guided discovery. Practice continued until they were able to solve all 11 steps for two problems in a row. Before learning, one group of participants was presented with an organizer which emphasized the main concepts, while for the other group, the advance organizer spelled out the formula to be used. Although both groups learned to criterion, the concept advance organizer facilitated performance on far transfer problems while the formula advance organizer facilitated performance on near transfer problems.

Preorganizers and Postorganizers

The indications are that organizers can have a differential effect on learning outcomes depending on their placement, either before or after the material to be learned (Mayer, 1976; Mayer, Stiehl, & Greeno 1975). As noted by Mayer (1979), however, "it might be argued that transfer tests do not allow the subject to give an accurate picture of what he or she knows" (p. 377).

To assess this question concerning transfer tests, Mayer and Bromage (1980) evaluated the differential recall of participants who were asked to remember selected portions of a text on computer programming. As in a previous study (Mayer, 1976), organizers were presented either before or after the text material. The authors predicted that:

Because the before group subjects integrate the new material within their past experience with the model, they would be expected to recall more idea units concerning general concepts about the computer operation and to make more inferences and intrusions about related ideas. Because the after group does not have a meaningful assimilative set, these subjects would be more likely to focus on recalling the technical idea units and to add more vague connectives and vague summaries. (p. 378)

The hypotheses were upheld. The before group recalled a greater number of conceptual units and produced more appropriate intrusions (i.e., information from other than the requested section that is relevant to the question) and novel inferences. The after group recalled more technical idea units but produced a greater number of inappropriate intrusions, connectives, and vague summaries. These results also supported the hypothesis that the locus of effect is at encoding since: (1) differential learning was produced despite the fact that both groups received the same materials and the same amounts of information, and (2) the results are consonant with those obtained under the organizer/no-organizer paradigm.

The results were also said (Mayer, 1979) to support the transfer results obtained in Mayer (1975, 1976) since the before group excelled on encoding conceptual ideas and forming relationships among ideas from different sections of information. This would seem to facilitate far transfer (e.g., being able to interpret what a given computer program might do). The after group excelled in retaining technical details which would be advantageous for near transfer tasks (e.g., answering questions pertaining to information that has a high degree of similarity to information in the text).

The effects of before and after organizers differ according to the organization of the text (Mayer, 1978). A group of college students read a text about imaginary countries organized according to name or attribute. The results indicated that the advance organizer group was less influenced by the organization of materials than was the postorganizer group. The before group could better answer questions that came from several frames of text than the after group,

while the after group performed more adequately than the before group if all the questions came from the same frame of text.

The before and after paradigm was used in a series of studies to investigate the effects of organizers on acquiring higher order rules (Mayer, 1977). For example, participants utilized a three-base system to count groups of letters to two errorless trials of 12 or 18 responses. Though the posttest revealed that both groups were able to generate the newly learned sequences without error, the before group performed more adequately on transfer tasks that required learned sequences to be expanded or addition problems to be completed, indicating that they had acquired a generative rule which could be applied to new situations. The after group appeared to have acquired lower order rules which were applied effectively only to the treatment materials.

Other investigators, however, have not found the preparadigm and postparadigm to differentially affect the encoding and retrieval of information (Barnes & Clawson, 1972; Bertou, Clasen, & Lambert, 1972; Graber, Means, & Johnsten, 1972). It might be argued, though, that their dependent measures were not sensitive enough to detect differences that might have actually existed. In point of fact, all three of these investigations used multiple-choice tests to assess treatment effects. In light of the assumptions of the Assimilation Encoding Theory, multiple-choice tests would not be expected to detect differences between groups. It has been argued (Mayer & Bromage, 1980) that dependent measures which assess the overall amount of information that has been retained may not be sensitive enough to detect the

selective learning that may have occurred or the nature of the intrusions and inferences that advance organizers may have influenced.

Lastly, facilitative effects have also been found for post-organizers. In three separate experiments, Bauman, Glass, and Harrington (Note 1) found that postorganizer groups scored significantly higher than the advance organizer groups. It may have been that the posttest measured facts and details rather than broader, more subsuming concepts.

Organizers and Ability

Some researchers have investigated the question as to whether there is an aptitude by treatment interaction in the use of advance organizers with individuals of varying levels of ability. Ausubel and Fitzgerald (1962) studied the effectiveness of an expository organizer as compared to an introductory passage in the learning of information pertaining to the endocrinology of pubescence. A comparison of the means of the experimental and control groups was found to be non-significant. However, when verbal ability as measured on the School and College Ability Test (SCAT) was used as a basis for blocking, significant results were found for the lower group in favor of the expository organizer.

Mayer (1975) confirmed this result. He hypothesized that advance organizers would be the least facilitative for individuals who would already have a meaningful assimilative set (i.e., high ability individuals) as opposed to those with lower ability whose "ideational scaffolding" might not possess the necessary anchoring concepts. In an experiment investigating the facilitative effects of advance

organizers on transfer, it was found that the advance organizer group excelled on far transfer items (e.g., to interpret what a particular program might do based on definitions from the text), while the no-organizer group excelled on items of near transfer (e.g., to write a single statement to solve a particular problem). The finding was strongest for individuals that were below average in their Scholastic Aptitude Test (SAT)-Mathematics.

Some further corroborative evidence has been provided by Allen (1970). This researcher employed a combination of advance organizers and questions to determine their effects on the learning of geography materials by ninth graders. Both immediate and delayed tests were employed. There was little difference between groups on the immediate test, though the advance organizers were facilitative on the delayed test, especially for the lower ability individuals. Higher ability participants found the organizers helpful on only the more difficult questions.

Grotelueschen and Sjogren (1968), however, found that advance organizers can facilitate the processing of information by higher ability individuals. They conducted two experiments, one with a group of intellectually gifted adults and the other with a group of graduate students. In both experiments, the treatments were found to facilitate the learning of new material beyond that of the control group.

Advance Organizers and Piagetian Concepts

In a novel application of the organizer concept, Lawton and his colleagues attempted not only to facilitate and accelerate the acquisition of meaningful verbal material (i.e., its content) but to

facilitate and accelerate the process by which the material is structurally organized. To assess this question, Lawton (1977a) pretested groups of 6- and 10-year-olds on materials similar to the test materials, to estimate their ability to use the Piagetian notion of the causal and logical "because." Two experimental groups, the first utilizing an advance organizer (AO) plus a supplementary lesson (SL), the second, just the organizer alone, were compared to a control group that received a nonorganizer introductory lesson plus the supplementary lesson. Posttest results indicated that there were no significant differences between experimental groups, but that both were significantly different from the control group. As expected, the 10-year-olds performed significantly and positively better than their younger counterparts.

A follow-up study (which utilized similar materials and the same design) (Lawton, 1977a) was conducted 5 weeks later. No significant differences were found between the posttest of the first study and the pretest of the second for each of the treatment groups. Also, there were no significant differences between the pretest and posttest of the second study, though interestingly there was no significant difference between the 6- and the 10-year-olds. The results indicate that advance organizers facilitate both the learning of meaningful material and concrete operations which in turn facilitate causal explanation and logical justification (another of Piaget's notions). A very similar study (Lawton, 1977b) again found that advance organizers (i.e., higher order concepts and rules) facilitated and accelerated the learning of meaningfully related subject matter concepts and logical operations.

In somewhat of a departure from the two previous studies, Lawton and Wanska (1979) studied the effects of three different advance organizers: (A01) high order social studies concepts, (A02) high order rules for hierarchical classification, or (A03) both together. The effects of these treatments were measured according to the Piagetian concept of hierarchical classification, the durability of learning, and the extent of near-near (i.e., the transfer of training to different stimuli of the same content area) and near-far transfer (the transfer of training from one content area to another). The results indicated an overall order of training effects on classificatory tasks: A03 $\rightarrow$ A02 $\rightarrow$ A01. Too, performance was found to be durable since it remained stable over a period of 5 months. Clear evidence for near-near transfer was obtained, though not for near-far transfer.

Interpretive Framework

A number of theoretical variations within the cognitive position have been put forth to explain the reason for, and the functioning of, advance organizers. Most involve the interaction of individual knowledge structures with incoming information. Ausubel (e.g., 1967) hypothesizes that organizers facilitate the inclusion and the longevity of meaningful information to existing schemata. In similar terms (Greeno, 1972), advance organizers facilitate the internal connectedness (the stability, clarity, and differentiation within a knowledge structure) and external connectedness (how incoming information is linked to other areas of knowledge) of existing knowledge structures. Likewise, Mayer (1979) specifically states that meaningful learning cannot be adequately explained unless the reception of information,

the availability of schematic structures, and the activation of the schematic structures are accounted for.

There is another theoretical formulation that seems applicable to some of the research discussed in this section but which has not been mentioned by any of its authors: transfer appropriate processing. Briefly, this implies that "the value of particular levels of analysis (i.e., levels of processing) seems to be relative to the types of test situations encountered later on" (Bransford, 1979, p. 66). Mayer's research has amply demonstrated this point. His studies are carefully planned and executed, not only to investigate the positive uses and limitations of advance organizers, but to highlight some of the deficiencies of past research in this area. One of these deficiencies was the use of dependent measures which are relatively insensitive or inappropriate to the types of learning that advance organizers may facilitate. To be more concrete, his research has shown repeatedly that advance organizers encouraged the integration of broader base concepts at the expense of detailed technical information, whereas the organizer presented after the treatment or the no-organizer excelled on learning such information. The point is, to detect differential levels of processing, the researcher must utilize the appropriate dependent measures.

Adjunct Questions

It was noted earlier that contemporary investigations into the effects of interspersed questions on the comprehension of text were begun within a neobehavioristic framework. Adjunct questions were hypothesized to stimulate "mathemagenic behaviors" (Rothkopf, 1970),

or "activities that give birth to learning." As exemplars of this concept, adjunct questions shape problem-solving behaviors in the course of learning by acting as discriminative stimuli.

The General Paradigm

Rothkopf (1966) presented questions either before or after text materials and compared the performances of these groups to two control groups. One of the control groups read the text (with just general directions) and did not see any of the treatment questions. The other control group was only given explicit directions to read the material slowly and carefully. To determine the effects of the knowledge of results, one of the questions before groups and one of the questions after groups received the answers to the two questions that accompanied each text segment before reading the segment itself (there were seven segments in all). Another group received the answers to all 14 questions before reading any of the text materials. Two other groups were included, a before group and an after group, that received the two questions with each segment but no feedback.

Two criterion tests were administered after completion of the training. One was intended to measure the general facilitative effects of learning (GT). It was comprised of 25 questions that were similar, but not identical, to the experimental questions. The other was designed to measure specific learning (EQRT). This test was made up of the 14 experimental questions that were used during training. On the general test, only the questions after no feedback group and the specific directions control group outperformed the second control group. The effects of questions on intentional learning was much more

pronounced. Every group that had received exposure to the experimental questions performed significantly greater than either of the control groups. The groups that received feedback outperformed those that did not.

In summary, postquestions facilitate the acquisition of incidental information, though neither prequestions or postquestions appear to affect differentially the acquisition of intentional information. These have been the commonly accepted trends for adjunct question research (Anderson & Biddle, 1975), though a careful scrutiny of the literature reveals otherwise. For example, Sagaria and Di Vesta (1978) varied both question placement (questions before, questions after, or questions before and after) and types of learning (intentional and incidental) and found incidental learning to be lowest in the questions before treatment and relatively equal in the remaining treatments. So far, there is nothing to suggest that Anderson and Biddle (1975) are incorrect. However, intentional performance was facilitated by the use of postquestions or postquestions plus prequestions (there was no significant difference between these two groups) as compared to prequestions alone, a definite departure from what has commonly been accepted. Other exceptions will be explicated in the following sections.

Type of Question

Some authors have varied types of verbatim questions (i.e., questions that require the recognition or accurate recall of the text materials) to determine the possible differential effects on the recall of information. Rothkopf and Bisbicos (1967) varied question

type in which case the answer was: (1) a quantitative term, (2) a common English or technical word, or (3) a combination of 1 and 2, and, question position (before and after) to observe any possible interactive effects between these two variables. In instances 1 and 3, postquestions produced significantly greater recall than pre-questions. For common English or technical terms alone, question placement was not a factor. The latter findings were supported in a study by Morasky and Wilcox (1970). They found, however, that if completion time was taken into account, the question before group outperformed the question after group on relevant, incidental, and total test scores. Rickards, Anderson, and McCormick (1976) provide more recent evidence that contradicts many of the latter findings. College students read an 800-word passage with a common word question or number question, i.e., numbers were imbedded in the text (or no question at all), after every two paragraphs of text. Intentional learning was equivalent for both types of questions regardless of their positions relative to the text. However, pre-and post-number questions produced greater recall than the control group, though only common word questions were found to produce this result. Lastly, none of the verbatim adjunct questions produced any facilitative effects when incidental learning was measured.

Incentive Conditions

Can incentive conditions modify some of the accepted relationships in questions research? Frase, Patrick and Schumer (1970) investigated the effects of varying levels of incentive, position of question, frequency of questions, and amount of recall. At the lowest incentive

level, the postquestion group performed substantially above the prequestion and control groups. The moderate incentive level evidenced little difference between the postquestion and control groups, though both were substantially above the prequestion group. Lastly, there was little difference among any of the groups at the high incentive level.

There was an interesting interaction between the level of incentive and the position and frequency of questions. Postquestions, regardless of frequency, did not seem to be influenced by the level of incentive. Pquestions, on the other hand, performed at the level of postquestions with infrequent questions and a large incentive. However, when questions were frequent, high incentive was not sufficient to overcome the apparent inhibitory effects of those questions on relevant retention.

Pacing of Questions

A number of additional studies have focused on the frequency of questions in text. Frase (1968a, 1968b) found that retention increased with the frequency of postquestions, but decreased with the increased frequency of pretreatment questions. It was also found (Frase, 1968b) that frequent questioning, either pretreatment or posttreatment, yielded accurate differentiations between intentional and incidental material leading to lowered performances on the latter without a corresponding increase in the former.

Other studies have produced contradictory results, however. Boyd (1974) did not find an effect for the frequency of questions and question position. Rickards and Di Vesta (1974) found a facilitative

relationship between the frequency of meaningful postquestions and retention, though no such relationship was found for verbatim postquestions.

Knowledge of Results

To reiterate an earlier discussion, Rothkopf (1966) demonstrated that the knowledge of results clearly affected intentional learning, nullifying any effects of the positioning of questions. This effect, however, may not always be the case. In a subsequent study (Frase, 1967), retention questions (incidental information) were found to be significantly influenced by a number of factors: knowledge of results, length of passage, and position of questions.

Levels of Questions

Carver (1972) cautioned against the generalization of the findings of verbatim level adjunct question research to learning situations that often do not require the verbatim memorization of materials. A number of researchers have expressed a sensitivity in this regard and have investigated the effects of varying the levels of questions that accompany text. Frase (1970, 1971) was one of the first to do so. He utilized prequestions which required the participants to assess (i.e., to infer) the validity or invalidity of each relative to the subsequent passage. Though he found little evidence to support the learning of inferences, those participants exposed to inferential prequestions retained more of the textual information than those exposed to the verbatim prequestions. Rickards and Di Vesta (1974) examined the interaction between level of postquestion (rote learning of facts, rote learning of ideas, meaningful learning) and type of learning

(intentional or incidental). Meaningful learning postquestions produced greater retention and more organized recall for both types of learning than any of the other types of postquestions. In a similar study, McConkie, Rayner, and Wilson (1973) employed five types of postquestions (factual, number, structure, recognition, and higher order) after each of the five topically distinct passages were read. After a sixth passage, all learners received all six types of questions, pertaining only to the information in that (the sixth) passage. Overall, the information learned appeared to depend on the type of question the learner was given.

Lastly, Rickards (1976) investigated how conceptual questions, which required learners to abstract information from large portions of text, would compare with verbatim questions in the recall of text information (within the before and after paradigm). Generally, conceptual prequestions generated better criterion test performance than conceptual postquestions, and verbatim postquestions yielded greater recall than verbatim prequestions. However, conceptual prequestions and verbatim postquestions produced significantly greater recall than the common knowledge questions utilized in the control group on the immediate test, though only the conceptual prequestions did so on the delayed test.

Interpretive Framework

The initial paragraph of this section of the review explicated the neobehavioristic beginnings of questions research. To reiterate, when written materials are studied, individuals not only learn content, but may also acquire general facilitative skills, that

is, inspection behaviors which are consistent with the training objectives. Questions are one of the controls of these inspection behaviors. This particular viewpoint has been the model for much of the research reported within (e.g., that conducted by Frase and Rothkopf), though a recent "shift" has produced a more cognitive interpretation (Rothkopf, 1976).

Others have been of the opinion, in explaining their results, that questions serve to influence the learners' expectations relative to the processing of text (Sagaria & Di Vesta, 1978). In their words,

. . . it can be seen that at one extreme are the expectations implied by the No Questions treatment that much of the material, but not all, ought to be attended to and tagged for retrieval. At the other extreme is the expectation implied by Pre Questions that only the answer to a given question is demanded by the experimenter (the author) and therefore requires attention, but even that answer is not tagged as sufficiently important for delayed recall. Accordingly, Pre Questions do not necessarily enhance acquisition and must seem redundant to the subject when compared to the No Questions control. Expectations developed by No Questions are dependent on all facets of the environment external to the experimental conditions and therefore provide a base level of performance (control) against which the effect of treatments may be judged. Post Questions can be viewed as inducing expectations. Initially, Post Questions will induce the same expectations as No Questions. With increasing experience, adaptation to Post Questions requires the development of a new expectation that the question asked (and answered) provide a criterion for the kind of information to be selected, encoded and tagged for later recall. (pp. 287-288)

Lastly, Rickards (1976) feels that verbatim postquestions foster the rote learning of isolated sentences by not encouraging the learner to determine the relationships among them and thereby integrating them into a more coherent whole. Evidence presented by Rickards and Di Vesta (1974) support this notion: ". . . verbatim postquestions did not yield any significant correlations between the recall of

statements directly questioned and those topically related to them" (Rickards, 1976, p. 216). Whereas conceptual prequestions force the individuals to conceptually integrate whole paragraphs of material, thereby leading to a more highly organized schematic structure and a more systematic retrieval plan at recall.

Pictures with Prose

This section will discuss the earlier and more recent work of the effects of pictures on the comprehension of text (much of which has been conducted within the framework of the hypothesis of no difference) and the relatively recent interest in the cognitive processing of verbal and pictorial information.

Initial Research on Picture-Text Interactions

Early forays into the effects of pictures on the comprehension of text were not encouraging. Miller (1938) found no differences between groups of elementary school children, whether or not they read passages that were accompanied by pictures. Others have confirmed these results. Vernon (1954) conducted two experiments in which instructional materials illustrated in different ways (e.g., pictures, black and white drawings) were read to or by children from grammar and secondary schools. Free recall and structured questions failed to show that any of the texts with pictures or illustrations facilitated remembering above that of the control group. The author did state that pictures did seem to facilitate reliably the recall of certain isolated facts, though no systematic analysis of this assumption was tested. Another pair of experiments (Vernon, 1953), with participants ranging in age from 15 to 19, supported these results.

Recent Research: Negative Findings

More recently, Samuels (1970) has corroborated the negative effects of pictures on the learning of prose. He reviewed a large number of studies and came to the conclusion that the use of pictures hinders the acquisition of a sight vocabulary and does not facilitate the comprehension of printed text. Though pictures appear to influence favorably children's attitudes towards reading, the studies are few and it is concluded that more needs to be done before a more definitive statement can be rendered.

Willows (1974, 1978a, 1978b) also presents a negative view (generally) regarding the interaction of pictures with text. His picture research has proceeded under the assumption that the inadequate development of selective attention is one of the bases for reading problems. In an initial study which examined the processing of text and which served as a basis for his later picture research, Willows (1974) presented a story to good and poor readers with the relevant lines typed in one color of ink (and double spaced) and the irrelevant lines (their meaning was consonant with the relevant lines, however) typed in another color of ink and placed between the relevant lines. As expected, the oral reading performance of the poor readers in both the experimental and control conditions (i.e., the relevant text only) was significantly less than that of the good readers. Further, the good readers' oral reading performance was unaffected by the irrelevant reading material as compared to the control group, though the poor readers' performance declined significantly. An additional and unexpected finding was that good readers made significantly more intrusion errors on the criterion measure (multiple-choice questions) than did the poor readers. Willows (1974) hypothesized that the skilled readers may employ an analysis by synthesis strategy

of reading for meaning. The reader may proceed by sampling the text to validate linguistic expectancies rather than by analyzing the passage in a word-by-word manner (Willows, 1974, p. 413). When the good readers answered the criterion questions, they appeared to sample "relevant information" from both the relevant and irrelevant lines; in his words, "scanning for meaning" (Willows, 1974, p. 414).

Based on the results of the aforementioned study, Willows (1978a) hypothesized that pictures in reading materials would interfere with reading performance and that the degree of susceptibility to distraction would be related to reading ability. He also hypothesized that intrusions in comprehension would be related both to the degree of relevance of pictures to the reading materials and reading ability.

These assumptions were evaluated in two experiments. Both involved reading sets of words in three conditions: control (words only), related (each word was paired with a picture related to it), and unrelated (each word was paired with a picture that was unrelated to it). The differences between the two experiments were the ages of the participants (second and third grades) and the locations of the words relative to the pictures (the words were either superimposed on top of the pictures or placed below them).

The results indicated that pictures decreased reading speed as compared to the control for both second and third graders. Also, unrelated pictures were found to produce significantly more interference in reading speed than unrelated pictures. In both experiments, there were more reading errors in the unrelated than in the related picture condition, especially for the poorer readers though neither picture condition was significantly different from the control groups. Generally, the overall results appeared stronger for the second graders than for the third graders, indicating that younger, less

skilled readers are more susceptible to the distractions that pictures seem to cause. Willows (1978a) extrapolates a little further and postulates that if pictures are present, children unconsciously try to use them as aids in decoding. If the child already knows the word, the child may be distracted and decoding will be slowed. If the child does not know the word, there is no guarantee that the child will attend to those features of the picture stimuli that would be appropriate in detecting the meaning of the word. If that occurs, the child will be misled as to the meaning of the word.

Willows (1978b) extended his related, unrelated, control picture design of a previous study (1978a) to see how it might interact, both with the difficulty of the words being used (lists of one-syllable nouns) and a more precise breakdown of reading proficiency (normal, good, and poor readers). Identifying pictures (i.e., the related condition) were found to inhibit reading times with relatively easy words, but to facilitate reading times with the more difficult words. This held across all levels of reading ability, but especially for the less accomplished reader. Unrelated pictures inhibited the reading performance (i.e., time) of all groups, though again the effect was most noticeable for the poorer readers. For decoding errors, identifying pictures did not influence good and normal readers' decoding accuracy, though poorer readers decoded more accurately when pictures were associated with the more difficult words.

Not everyone adopts such a pessimistic point of view regarding the general use of pictures in text. Levin and Lesgold (1978) presented a review of the research that is decidedly more positive in its evaluation of the effects of pictures on prose, though one must

be careful in interpreting, and generalizing from, their conclusions. A study was included in the review only if the prose passages were presented orally (so as not to confound decoding with comprehension), if the participants in the study were children, if the reading materials were fictional narratives (an attempt to establish some level of control over past knowledge), if the pictures were completely overlapping adjuncts to the texts (this implies that the passages must be illustratable and concrete), and lastly, if learning was demonstrated by factual recall (used to distinguish between recall of facts and assessments of inference, theme, and the like). Their conclusion was "that picture facilitation of children's prose learning is ubiquitous" (p. 240). This conclusion was said to hold across baselines (even when comparisons are made with listen twice controls), methods of presentation (e.g., pictures presented simultaneously with text, following each sentence or following each passage), learner characteristics (e.g., age, sex, socioeconomic status (SES)), passage characteristics (the length and complexity of passage), levels of recall (e.g., verbatim and nonverbatim questions), and time (e.g., immediate and delayed assessment).

Recent Research: Interaction

Such findings about main effects, however, do not seem to represent this area of research adequately. The studies to be presented within the next few lines will present a point of view showing that interactions are a common result of many of these research efforts. Rohwer and Harris (1975) investigated the prose learning capabilities of high SES white youngsters and low SES black youngsters as a

function of presentation media, test item structure, and response methods. There were seven methods of presentation: three single media (e.g., print alone) and four combined methods (e.g., oral plus print). Of most interest was the interaction between race, SES, and presentation method. High SES white children performed as well in single media as in combined media methods. In fact, oral plus print depressed recall below that of any of the single media methods alone. For low SES black children, no one medium was found to be sufficient; rather, any of the various combinations seemed to facilitate performance. Oral presentation with pictures was found to be optimal.

Koenke and Otto (1969) employed fifth-grade reading materials to assess the interactions of pictures and text on the comprehension abilities of third and sixth graders. For the third-grade students, the picture plus text condition was not found to be any more facilitative than the text condition alone. It appears that picture supplements were sufficient to overcome the processing of textual materials by children at this reading level. The sixth-grade subjects, however, did use the pictures productively. In another study, Peeck (1974) found a positive effect for the pictures plus text condition (as compared to a text only control) when comprehension was measured 1 day and 7 days after reading the story. No significant differences between the two groups were found on the immediate test. A study by Haring and Fry (1979) found that pictures enhanced the recall of the main ideas but not the lower level details (again demonstrating the importance of the criterion measure). Other results indicated that the level of detail in the picture did not seem to make a difference, that the

benefits of pictures were present immediately and over time, and that the effect of pictures held for both fourth- and sixth-grade children.

Lastly, there is a study that looks at the picture-text relationship from a somewhat different viewpoint. Stone (1977) assessed the effects of text added to pictures on the ability of college students to assemble a hand truck. The addition of text resulted in a reduction of the time spent in looking at the illustrations and more accurate and speedy task performance.

Interpretive Framework

Many of the picture studies discussed above were conducted within the framework of nondirectional or experimental no difference hypotheses. However, there has been a significantly growing body of literature that has directly addressed the question of the manner of cognitive processing of pictorial and verbal information. A selected sample of this literature will be explicated in the paragraphs to follow.

The effect of context on the interpretation of ambiguous passages. To begin, one might question if it is sufficient to postulate that comprehension involves only the analysis of the deep structural relations of a group of sentences (e.g., Katz & Postal, 1964). In a series of studies (though only the first of these will be discussed), Bransford and Johnson (1972) directly addressed this issue. They hypothesized that relevant context (created through the use of pictures) is a prerequisite for the comprehension of textual information. The general design consisted of an acquisition phase and two dependent variables: comprehension ratings and recall. There were five

independent groups: a no-context group which heard only the passage and did not see the picture materials (line drawings depicting elements in the passage), two context groups which saw the drawing either immediately before or after the text, and two partial context groups (before and after) which saw a modified version of the drawings. In this case, the elements of the picture were slightly rearranged, though the amounts of information were the same.

The participants in the context before group recorded significantly higher comprehension ratings and recalled significantly more idea units than the participants of any of the other four groups. Bransford's and Johnson's hypothesis was confirmed, indicating that if the appropriate retrieval cues are present at input and the appropriate relations exist among those cues (the partial context groups lacked this), then comprehension will be facilitated.

The role of pictures in text have also been discussed relative to the depth of processing (Craik & Lockhart, 1972) and encoding models (e.g., Anderson, 1978; Paivio, 1971; Pylyshyn, 1973).

Depth of processing and encoding models: Theoretical positions.

The notion of the depth of processing argues basically that different levels of rehearsal and processing result in different levels of analysis and long-term retention. If one concentrates on the superficial aspects of stimuli such as the "t" in train, analysis and retention will be noticeably inferior when compared to the processing and retention of someone who has attended more to the meaning of the word.

The encoding theorists fall into two distinct categories: a dual code model (a variant of the depth of processing approach) and a

propositional (i.e., amodal) model (Anderson, 1978). A basic tenet of the former is that the coding of information about the environment is modality specific. Paivio's (1971) dual coding hypothesis is a prime example. Both imaginal and verbal codes are available for the encoding of incoming stimuli, though their involvement is differentially dependent upon the concreteness of the information. In Paivio's words, "The summative ability of both codes is highest in the case of pictures, intermediate for concrete nouns and the least for abstract nouns" (p. 150). If considered singly, imaging codes for pictures and verbal codes for words have the highest availability. The strength of memory can be thought to be monotonically related to the availability of the two codes for the representation of information. For a similar point of view, see Kosslyn and Pomerantz (1977).

The propositional theorists posit an abstract code that is neither imaginal nor verbal (i.e., it is amodal). Rather, there is a code or a deep structure that underlies both. Imaginal and verbal processes are emergent properties of this code. This concept implies:

- a) that it (propositions) does not correspond to a raw sensory pattern but, rather, is already highly abstracted and interpreted, b) that it is not different in principle from the kind of knowledge asserted by some sentence, and c) that it depends on the classification of sensory events into a finite set of concepts and relations
- (Pylyshyn, 1973, p. 7)

Anderson (1978) presents an interesting alternative to the prior formulations. His stance is essentially noncommittal as to whether imagery is emergent from a dual code or an amodal code. Though parsimony and efficiency are given some status as possible criteria for deciding this issue, he feels the outlook for making such a decision is a pessimistic one. If Anderson seems to be making any

commitment at all, it is towards a tri-code theory (visual-spatial, verbal sequential, and abstract propositional).

Encoding: Amodal or dual codes. The following study attempted to explore the viability of a dual code as opposed to an amodal approach. Odom and Nesbitt (1974) investigated the relationships between the comprehension of linguistically and pictorially presented information and attempted to differentiate between theories that suggest a single comprehension system with those that suggest dual code systems. Pictorial and linguistic information were presented, via a paired associate method, in either a relational (elements of the picture were spatially related; sentences expressed this relationship) or nonrelational context (neither were relational, only the linguistic aspect was relational, only the pictorial aspect was relational). The authors assumed that:

A single system theory would predict that a relationship portrayed in two modalities would be no more facilitative of recall than a relationship predicted in one modality. A multisystem [dual code] theory would predict better recall performance when the relationship is presented in two modes than when it is presented in one. (p. 401)

The participants were given two practice items and then informed that they would see all the pairs once before they would be asked to state what went with each member of a pair. The results indicated that a relationship expressed by both linguistic and pictorial materials facilitated recall above those groups who saw a relationship expressed in one modality only. A relationship in either mode facilitated recall above no mode at all. The results were interpreted as supporting a dual coding hypothesis (Paivio, 1971). It seems, however, that these

effects could be interpreted as due to the effects of the redundancy of information and not necessarily to dual encoding.

Encoding: Dual codes or depth of processing. But what of the differential predictions of the dual code and depth of processing models? From one perspective, D'Agostino, O'Neill, and Paivio (1977) have argued that these two models are somewhat comparable since both embrace the idea of the depth of processing, though the models do differ in postulating what is responsible for memory performance. According to the depth of processing model, retention is determined by the level of rehearsal at encoding while the dual code hypothesis states that it is the number of codes and the type of code that determine the level of retention. The design of the study is similar to that reported by Craik and Tulving (1975) in that the participants were required to judge phonemic, semantic, and structural characteristics of tachistoscopically presented events. In addition, though, separate groups made judgments on abstract words, concrete words, or pictures. In the Craik and Tulving (1975) experiment, semantic processing facilitated recall above the other two groups (phonemic was greater than structural) because, as hypothesized, it involved deeper levels of processing. However, D'Agostino, O'Neill, and Paivio (1977) predicted that the latter would occur only in the concrete word condition. For the picture condition, it was predicted that phonemic and semantic processing would produce essentially the same results (since each type of processing will activate both verbal and imaginal codes) above that of structural processing (in which only a single code will be activated). With abstract words, phonemic processing should produce higher recall than structural processing since it too will evoke the

two codes. All predictions were upheld. The dual code model was interpreted to be the most viable one.

The superiority of the dual coding hypothesis has not been universally accepted, however. Nelson and Brooks (1973a) found that the phonetic features of words are as valuable in processing low imagery abstract words as they are in the processing of more concrete high imagery verbal materials. In a follow-up study, Nelson and Brooks (1973b) sought to determine "if the coding of phonetic attributes was dependent upon initiating the information processing sequence from a verbal stimulus" (p. 44). They utilized the paired associate paradigm with high or low similarity pictures or their labels as the stimuli. Response terms were all high imagery words. One half of the participants were instructed to name the picture before anticipating the response while the other half were given the usual instructions for paired associate learning. Similarity interfered with the acquisition of responses most noticeably in the word only condition, was only moderately impairing when the participants were required to name the pictures, and did not interfere at all in the acquisition of responses in the picture only condition. These results were interpreted to demonstrate that pictures can function as effective memory representations without evoking their corresponding verbal codes, that the labeling of pictures is not a spontaneous process, and that the generally superior retention of pictures (as opposed to their labels) is not due to dual encoding.

Another series of experiments (i.e., 1-3) conducted by Nelson and Reed (1976) investigated the boundaries of the independence of the naming process by manipulating both the relationships between the

labels of the pictures and their responses (e.g., associatively related or unrelated, rhyming or not rhyming) and the length of the paired associate list. These studies confirmed the results of Nelson and Brooks (1973a, 1973b).

Experiment 4 of this series of studies (Nelson & Reed, 1976) directly considered levels of processing as an alternative hypothesis to the dual codes model to explain the superiority of pictures. Though the authors hypothesized that there were qualitatively different representations for pictures and their verbal counterparts (an assumption accepted within the dual code model), "greater stimulus effectiveness may be related to differences between them and their verbal counterparts at a given level of processing" (p. 50). To evaluate this assumption, procedures common to the other three studies were utilized except that the stimuli were either high or low in "conceptual" similarity. The results indicated that "equivalent amounts of conceptual interference are generated by each type of representation, suggesting that conceptual or taxonomic meaning is coded independently of the type of representation initiating it" (p. 56). The authors interpret this finding as supporting a levels of processing model.

Pictorial schemata. The studies discussed so far have examined the processes of encoding, but have not considered what "kinds" of information are contained in picture schemata. Mandler and her co-workers have conducted a number of experiments (e.g., Mandler & Johnson, 1976; Mandler & Parker, 1976) to provide some answers to this question. For example, Mandler and Ritchey (1977) investigated immediate and longer terms of retention (1 day, 1 week, and 4 months)

for black and white drawings of naturalistic scenes. This was accomplished through the recognition of eight different types of transformations of both organized and unorganized compositions. The results indicated that pictorial schema contain an inventory of objects and the relative locations of these objects to each other, some information concerning the relative orientations of objects, and little or no information about the descriptive characteristics of objects or the general spatial organization of the entire scene.

Verbal organizers compared to visual-spatial organizers.

Studies of the comprehension of text materials have generally shown superior memory for higher order versus lower order text structure (Anderson & Pichert, 1978; Anderson, Spiro, & Anderson, 1978; Pichert & Anderson, 1977; Spillich et al., 1979). Since verbal organizers are generally constructed around higher order constructs and have been shown to facilitate the comprehension of text (e.g., Mayer, 1976) the conclusion can be drawn that higher order structure can facilitate the comprehension of other related higher order structures.

The visual-spatial organizers used in this thesis do not depend on the semantic and syntactic constraints of spoken or written discourse but on their hierarchical-diagrammatic structure to attempt to convey the meaning and the structures of the text materials. However, Mandler's (e.g., Mandler & Ritchey, 1977) studies on picture schemata indicate a relatively good memory for the relative positions of components of pictures to each other but a generally poorer memory for the spatial organization of the entire scene. In this thesis, the overall spatial organization of the pictures parallels the coherency and the structure of the passages. If visual-spatial advance

organizers interact with text in the same way as verbal organizers do, you would expect the results to be the same. If Mandler's conclusions are correct and if they generalize to the advance organizers used in this thesis it may be that the preorganizers will not complement the organization of the text and therefore not facilitate memory of it.

The placement of pictures relative to text. There is a lack of research concerning the effect of the locations of pictures relative to text. Some of what has been done has indicated that pictures (given the logical arrangements of the elements of these pictures) can provide an appropriate context (i.e., pictures before) for the interpretation of text beyond what would have occurred if the text alone had been presented (Bransford & Johnson, 1972). Also, for early readers (second and third grades), pictures (with words superimposed on top of them or placed beneath them) have been shown to slow the process of reading and to increase the number of errors (a very predictable result given Smith's (1978) notion of tunnel vision) especially for poorer readers.

For this study, the work of Bransford and Johnson (1972) would seem to be the most germane. Their sample and the level of coherency of their pictures are comparable to those in this thesis. Too, the effects of pictures on young readers seems to decrease as proficiency in reading increases, even in the early grades. It is assumed, therefore, that the same distracting effects of pictures would not be observed in college students.

Summary

This chapter discussed three areas of research that have employed either the paradigm of materials before or materials after the to-be-learned information, or pictures in conjunction with text: advance organizers, adjunct questions, and pictures with prose.

Advance organizers. Advance organizers are materials presented before new learning which theoretically can facilitate the interaction of that material with the individuals' cognitive structures. This construct was discussed in context of its cognitive beginnings (e.g., Ausubel, 1960) and current research applications (e.g., Mayer, 1979). Though there are some disagreements as to the effectiveness of advance organizers, Mayer (1979) has concluded that if they are adequately conceptualized and constructed, they will facilitate the learning of higher order structures and rules when compared to postorganizers or no organizers at all.

Adjunct questions. The neobehavioristic beginnings of adjunct questions (e.g., Rothkopf, 1965), i.e., verbatim level questions presented either before or after text, stressed that questions would facilitate both the acquisition of content and "inspection behaviors" consistent with the training objectives. The general consensus of this early work was that postquestions facilitated the acquisition of incidental information, but that neither prequestions or postquestions differentially affected the acquisition of intentional information beyond that of no questions at all (Anderson & Biddle, 1975). Later research, however, has manipulated other variables, e.g., level of questions, and demonstrated exceptions to the aforementioned consensus. For example, Rickards (1976) showed that conceptual prequestions could

act in a manner similar to verbatim postquestions by encouraging broader learning outcomes.

Pictures with prose. Early studies on the effects of pictures on the comprehension of prose were generally conducted within the framework of the hypothesis of no difference. The results were usually presented relative to the presence or absence of hypothesized outcomes without the interjection of noticeable theoretical biases. Later research has clearly defected from this trend. Questions about the effects of pictures have become much more complex (e.g., Rohwer & Harris, 1975), and there has been a great deal of interest in the reasons for these effects. This has involved such constructs as levels of processing, amodal versus multimodal encoding, and picture schemas.

Research Hypotheses

The problems and research discussed in the previous pages have led to the following hypotheses:

1. Theoretical formulations (e.g., Ausubel, Novak, & Pinesian, 1978) and empirical investigations (e.g., Mayer, 1979) have pointed to the positive effect on recall of advance organizers as opposed to postorganizers or no organizers at all. Though generally the functions of advance organizers have only been vaguely specified (e.g., advance organizers provide a meaningful assimilative set which postorganizers do not) the implication is that advance organizers prime relevant cognitive structures, facilitating their accessibility and increasing the probability of the incorporation of the new information. This leads to broader and more stable learning outcomes.

Based on these assumptions it is predicted that: (a) the diagram-text (DT) condition will produce significantly more correct responses than the other three groups exposed to the sequential presentation of materials (diagram-text (DT), text-diagram (TD), and text-text (TT)), and, (b) the DT condition will also be superior to the ST group, which saw the diagram and text simultaneously.

2. In an attempt to improve the precision of the advance organizer model, Mayer and Bromage (1980) hypothesized and tested the notion that advance organizers would facilitate the processes of elaboration and inferencing relative to existing knowledge. At recall, this would lead to the recollection of a greater number of conceptual units and more appropriate intrusions and novel inferences. Postorganizers, however, would not facilitate these processes and would lead to the recall of a greater number of inappropriate intrusions, connectives, and vague summaries. The hypothesis was confirmed.

This information leads to the following prediction: the advance organizer group will commit fewer errors than either the postorganizer group or the control groups on both criterion measures.

3. The effect of familiarity (i.e., meaningfulness) on learning is well documented in psychology. Cleutat, Stockwell and Noble (1958) found that the more meaningful a pair of words were, the more quickly and easily they were learned. More recent investigations have shown that the meaning individuals bring to certain situations can effect the interpretations of those situations (e.g., how a text is interpreted, Pichert & Anderson, 1977) or how those situations are encoded in memory and later recalled (e.g., Spiro, 1980).

Realizing the potential effects of familiarity on the encoding and recall of information, steps were taken to control for this factor (the rating form that will be discussed in the Methods chapter). It is hypothesized, therefore, that familiarity will not influence performance on the criterion measures.

4. The construct of nonspecific transfer implies that there can be a carry-over of skills and strategies from one task to another that does not result simply from the similarities between tasks. Harlow (1949) demonstrated this in his research with nonhuman primates. Interproblem transfer has also been shown in young or retarded children (Brown, Campione, & Barclay, 1979; House & Zeaman, 1963). For example, Brown and co-workers trained educable retarded children to use a strategy of "stopping, checking (self-testing), and studying (if you need to)." Not only did such training improve their performance on the immediate task but the children spontaneously transferred this strategy to new tasks and new materials. Appel et al. (1972) have also shown that deliberate strategies for remembering develop only gradually as children progress through the early elementary grades.

Assuming that the participants of this thesis, as college students, have developed general overall strategies (i.e., metacognitions) for dealing with a wide variety of materials in a wide variety of situations, and that these will readily adapt to new situations and materials, it is hypothesized that they will gradually improve their performance (i.e., recall of information) over the sequence of the three content areas.

CHAPTER III

METHOD

Communicating new and novel information can be accomplished in a variety of ways. This thesis will examine information communicated by diagrams alone, by text alone, and by diagrams in combination with text (both sequentially and simultaneously).

Design

There were two between-subjects factors: type of material presented first (diagram or text) and type of material presented second (diagram or text). These were orthogonally crossed, resulting in four experimental groups (diagram-diagram, DD; diagram-text, DT; text-diagram, TD; text-text, TT). An additional experimental group saw the two types of materials simultaneously (ST). Thus, there were five experimental groups overall. The within-groups factors were familiarity (i.e., the content areas rated as least familiar; 4, 5, 6) and sequence (i.e., the presentation order of the content areas; first, second, third). A balanced $2 \times 2 \times 3$ (with an additional group) mixed analysis of variance was implied for each analysis with either familiarity or sequence as the within-subjects factors.

Participants

Sixty undergraduate volunteers from an introductory level educational psychology course from The Pennsylvania State University served as participants in this experiment. All received credit toward their

final grade for their participation in accordance with approved program policies.

Materials

The materials consisted of a rating form and six diagram-text pairs.

The content areas for the diagram-text pairs were: (a) Factors Influencing Aggression, (b) the Nervous System, (c) Energy Cells, (d) the Federal Reserve System, (e) Triangular (Colonial) Trade and Mercantilism, and (f) the Feudal System.

Rating forms. The rating forms were designed to control for the participant's familiarity with each of these content areas. The entire form is reproduced below.

Please rank the following titles according to your familiarity with them. Place a one next to the most familiar topic (one that you feel you are very familiar with), a two next to the topic that is just slightly less familiar to you and so on through six which will be the area that you are least familiar with.

- _____ Triangular (Colonial) Trade and Mercantilism
- _____ The Federal Reserve System
- _____ Factors Influencing Aggression
- _____ Energy Cells
- _____ The Feudal System
- _____ The Nervous System

Only those content areas that each individual participant numbered as 4, 5, and 6 were included in the experiment for that individual. In

order to be assured that the order of the content areas on the rating form was not having an effect on the ratings, a second form was made in which the order was revised. After the first 30 participants had completed the experiment, the experimenter pulled their individual rating forms and tabulated the number of times each content area had been given a particular rating. It was found that three of the first four content areas on the test were most frequently designated as the least familiar. The frequencies are given in Table 1. The experimenter then constructed a new form with the content areas rearranged from the most familiar to the least familiar (i.e., Factors Influencing Aggression was placed first, the Nervous System second and so on through Triangular (Colonial) Trade and Mercantilism which was placed last). This rating form was used with the next 30 participants. After this group had completed the experiment, their rating forms were also pulled and the same tabulations were made. The frequencies are given in Table 1. The two groups of 30 exhibited considerable consistency: the three content areas designated as the "least familiar" were the same for both forms (i.e., Energy Cells, the Federal Reserve System, and Triangular (Colonial) Trade and Mercantilism).

Texts. Texts were constructed for each of the content areas listed above (six in all). Each was comparable in length (225 to 300 words) and contained from 37 to 52 units of information. A more specific breakdown is given in Table 1. In order to identify the latter characteristic each sentence of each text was partitioned into the number of relevant pieces of information contained within it. For example, a sentence which contains five "idea units" is "(the federal reserve system) (is unique among the banking systems of the

Table 1

Number of Times Content Areas Were Designated as Least Familiar on Rating Forms 1 and 2, the Length of Text, and Number of Idea Units in Text

Content Areas	Form 1	Form 2	Length of Text	Number of Idea Units in Text
	Number of Times Designated as Least Familiar	Number of Times Designated as Least Familiar		
Triangular (Colonial) Trade and Mercantilism	24	20	272	55
The Federal Reserve System	23	21	288	44
Factors Influencing Aggression	4	6	300	46
Energy Cells	18	23	269	37
The Feudal System	12	15	300	53
The Nervous System	9	5	252	44

world) (since it attempts to balance the interests of business) (and government) (by promoting stable economic growth)." Each text was comprised of two to four paragraphs and was given an appropriate title of no more than four words. The individual texts were assumed to be of comparable difficulty since they were abstracted from intermediate level high school textbooks. Finally, all began with a general statement of the topic which was elaborated upon in the sentences that followed it.

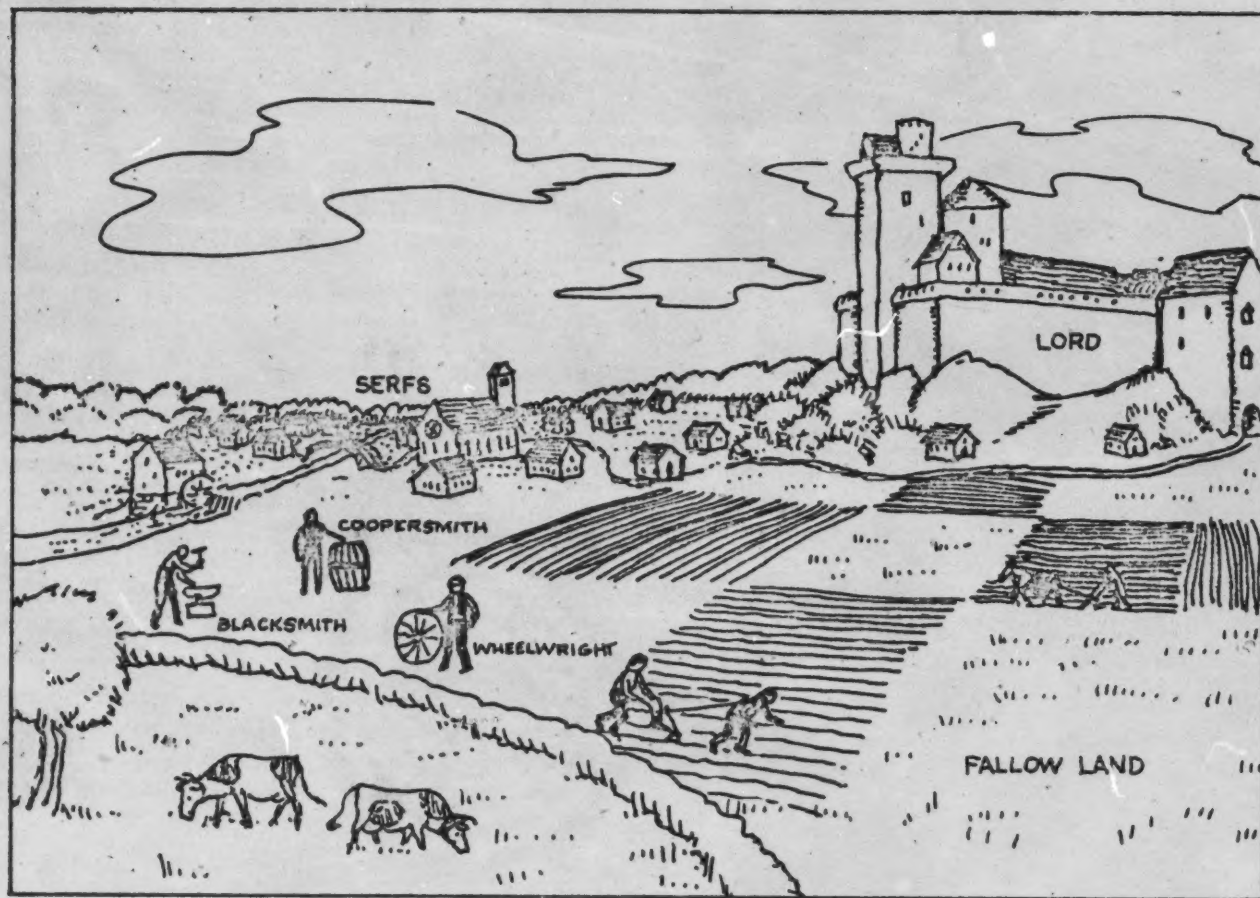
Diagrams. One of the diagrams (for the Feudal System) contained more contextual detail than the others. The illustrations (diagrams) accompanying the text were similar to each other in that each: (1) had information that was comparable with the text, (2) was not inclusive of the total amount of information in the text, (3) made no direct reference to any of the information in the text, (4) contained enough information to enable the viewer to construct a general though logically complete overview of the more substantive information in the text, (5) used word labels to identify their major components, and (6) was given a title that paralleled exactly the title of the corresponding passage. As an example, the Feudalism passage emphasized the economic nature of the system, the living conditions of the lord, and the living and working conditions of the serfs. Though the accompanying diagram did not convey a complete and detailed description of these points, its structure did convey the main ideas, in a general way, by emphasizing the imposing and overseeing nature of the castle (labeled "lord") in comparison with the lesser, less-imposing, living conditions and occupations of the serfs.

All diagram and text materials were printed on separate 8½ x 11" sheets of paper. One-inch margins were employed to establish a level of conformity in the amount of space used. An example of one of the six diagram-text pairs (the Feudal System) is shown in Figure 1 (see Appendix A for all other diagram-text combinations).

Test of Retrieval

There were two tests of achievement directed toward measuring information from the text: a free recall test and a short answer test. The free recall test was used to assess how much of the story the participant was able to remember without external cues. The short answer test was also used to assess the participants' knowledge but provided a number of cues in the form of questions. The free recall measure simply contained a cover sheet (with directions) and three blank sheets of paper on which the responses were to be recorded. The short answer test was comprised of a cover sheet followed by three pages of seven questions each. On each page were questions regarding the content of a particular passage. "Wh" questions were the most frequent (e.g., "What were the various occupations of the peasants?"--the Feudal System) though other questions required the participant to describe (e.g., "Describe the chemical reactions at the zinc electrode"--Energy Cells), explain (e.g., "Explain the effect of population pressure"--Factors Influencing Aggression), or define (e.g., "Define a nerve impulse"--the Nervous System). Answers were restricted to three lines. Figure 2 contains an example of the short answer test for the Feudalism passage (see Appendix B for all other cued recall tests).

THE FEUDAL SYSTEM



The Feudal System

Feudalism, the economic system of the European Middle Ages centered around the exchange of goods and services. A lord who might own a large tract of arable land (fief) would divide this land among a number of men (vassals) who in turn would subdivide their land among the peasant families. Generally, these were farmers though others included mill operators, blacksmiths, wheelwrights, coopers, or other craftsman necessary for the well-being of the feudal community. In exchange for the lord's protection, the use of his land and tools, and the social and economic order that was a result of the feudal system, the peasant family gave its life and work.

There was a great difference in living conditions between the lord and his serfs. The lord lived in a large manor or castle, usually perched on a hill so as to facilitate the sighting of approaching intruders or enemies. The castle served a dual purpose as home and fortress and was generally built with high stone walls, towers, and surrounding canals or moats. The castle was cold, damp, and generally uncomfortable. The serfs condition was even more undesirable. All families lived in one-room wood or mud-walled huts, with straw roofs, dirt floors, and openings covered by oil paper for windows. These were organized into small communities or villages. Sickness was commonplace among the poor families and children often died at early ages or were crippled by sickness early in life.

The working conditions were very unsophisticated. The lord sometimes provided his serfs with tools and oxen (which grazed in common pasture) but very often human power was the only means of pulling the plows through the fields. Rotating crops was unknown to them so they practiced the three-field system by planting two fields and allowing the third to fallow so as to regain its fertility.

Figure 1. An Example of a Diagram-Text Pair: The Feudal System

The Feudal System

- (1) Define the concept of Feudalism.
- (2) How was land divided?
- (3) What were the various occupations of the peasants?
- (4) What were the functions of the castle?
- (5) Describe the serfs' living conditions?
- (6) Describe the serfs' working conditions (farmers).
- (7) Explain the concept of the rotation of crops.

Figure 2. Short Answer Test for the Feudalism Passage

Follow-Up Questionnaire

The follow-up questionnaire was designed to briefly assess the clarity of the directions, preferences, and the induction of treatments (i.e., the use of pictures in reading). For example, one question asked:

"If you read the passage first and saw the picture second would you have preferred it the other way around (the picture first)?"

Yes _____ No _____ Does not apply _____

Why? _____

The questionnaire is included in Appendix C.

Procedure

Upon arrival at the experimental laboratory all the participants were randomly assigned to one of the five treatment groups with the constraint that there be one participant per treatment group for each five participants.

Orientation of participants. There were one or two participants per session. In the latter case, each participant was seated so that one could not see the materials of the other. Each participant was told that they were to participate in a (two-session) study of learning and memory. During the first session they were told that they would be presented with the materials to be studied. They were also informed that the subsequent session, 2 days later, would involve tests of this information (the number and type of tests were not specified). After the experimenter was assured that all participants

understood the general procedure, the participants were given the rating form and asked to complete it.

Once the participants had completed the rating form, the experimenter collected them and immediately collated the task materials for a given participant according to that person's experimental condition and the ratings given by that person of the content areas (this was done in the presence of the participants but out of their immediate visual field). A separate packet was made for each content area (the structure of the packets is discussed below). All three were placed face down in front of the subject (their sequence, i.e., which came first, second, and third, was random). For example, if an individual (regardless of experimental condition) designated Triangular Trade, Feudalism, and Energy Cells as the most unfamiliar topic area (4, 5, and 6 on the rating form), those would be the three content areas included in the experiment for that particular individual.

The presentation of the material in each packet followed the same format for conditions DD (diagram-diagram), DT (diagram-text), TD (text-diagram), and TT (text-text): (a) the directions of how to study the stimulus materials, and (b) a page containing the first stimulus (diagram or text), another page of directions (again, telling the participants how to study the stimulus materials), and ending with a page which contained the second stimulus (diagram or text). Blank pages were placed before each of the diagrammatic stimuli to further control for the amount of time spent studying the material since it might have been possible without the blank page, to see through the directions page sufficiently well to pick out some details of the diagram when reading the directions.

The following listings give the precise orderings of materials for each condition:

DD^a

- (1) 1st page of directions^b
- (2) blank page
- (3) diagram (2 min)
- (4) mental review (1 min)
- (5) second page of directions
- (6) blank page
- (7) diagram (2 min)

DT

- (1) 1st page of directions
- (2) blank page
- (3) diagram (2 min)
- (4) mental review (1 min)
- (5) second page of directions
- (6) text (2 min)

TD

- (1) 1st page of directions
- (2) text (2 min)
- (3) mental review (1 min)
- (4) second page of directions
- (5) blank page
- (6) diagram (2 min)

TT

- (1) 1st page of directions
- (2) text (2 min)
- (3) mental review (1 min)
- (4) text (2 min)

^aTime limits are indicated in parentheses. The times for the study of text and for the study of diagrams were the same in all conditions.

^bParticipants were given as much time as they needed to comprehend the directions. Usually 1 to 2 minutes was all that was needed for any one page of directions (the maximum was 4 to 5 minutes).

Once the experimenter had finished collating the materials and had placed them in front of the participants, they were instructed to take one packet off the top of the pile, turn it over, and begin reading the information on the cover page. The cover page contained

a general statement of the purpose of the study, the directions, and a request that the participants ask questions if they had any doubts at all about the procedures. More specifically, they were told what stimulus would follow the first page of directions (diagram or text) and were instructed to study the information and to integrate the general concept with the facts and details. The directions specified a 2-minute time period for studying each part of the material. Once the participants finished reading the directions, they listened to a statement read by the experimenter reemphasizing the key points of the written directions. Again, the experimenter asked if they had any questions.

Once the participants understood what was required, they were told to begin. At the end of the first 2 minutes (during which they would have studied a diagram or text), they were then instructed to close their text booklets and to think about the information studied for 1 minute. They were then told to turn to the next page of directions. These instructions paraphrased those on the cover page with two exceptions. First, they stated whether the next stimulus would be identical to the stimulus they had just seen (DD and TT conditions) or just similar to the previous stimulus (DT and TD conditions). Second, the participants were told to integrate conceptually both sources of information (i.e., the first and second stimulus). Again, a 2-minute time limit was imposed. When time had expired, they were instructed to put that set of materials to one side and to take the next set. The procedure was repeated for each of the three content areas.

As an example of the procedure described above, participants in the DT condition studied the diagram (the first stimulus) for 2 minutes, thought about the information in the diagram for 1 minute, and then studied the subsequent text for 2 minutes. The procedure for the TT condition was identical with the exception that the same text was read twice. No diagram was seen.

The stimulus materials (diagram and corresponding text) for the ST condition were randomly arranged side by side (i.e., which was to be placed on the left or right) on pieces of 11 x 14½" computer paper. The first page of directions was the same for this group as for the other four although the participants were told that they would see both a diagram and a text, not one or the other. They would study the two stimuli for 2 minutes (again, the instructions were to conceptually integrate the information from the diagram and text), think about the information for 1 minute, and then study the same two stimuli again for another 2 minutes. All other aspects of the procedure remained the same as in the other four experimental groups.

Testing Phase

During the second, or test phase of the experiment, all test materials were given in the same order: free recall, short answer, and questionnaire. The free recall instructions stressed that the answers should be written (the use of diagrams was not allowed), well planned and well integrated (i.e., the main ideas integrated with the facts and details).

The instructions stated: For each of the topic areas (three in all) write (do not use pictures or diagrams in your answer) as much as you can recall integrating the information as much as possible. Plan your answer, organize the main ideas, and include details, avoiding the use of unexplained names and terms unless you absolutely cannot remember any of the related information.

Questions were encouraged if there were any doubts about procedures. Once they had finished reading these directions, the experimenter read a statement reemphasizing the above points. If they could not remember one or more of the topic areas, they were told the title(s) of the passage(s). Only 3 of the 60 participants had to be told the title of a passage. They were instructed to begin after all inquiries were answered. There was a 30-minute time limit for answering all the questions on the free recall test.

The short answer test was administered upon the completion of the free recall test. The instructions stated that there were three pages of seven questions each (one page per topic). Again, answers were to be well planned and limited to the spaces provided. Completion of the short answer test (a limit of 30 minutes) and the questionnaire to follow (it generally took no more than 10 minutes to complete) marked the end of the experiment.

Scoring

A subset (one-fifth) of the three free recall and three short answer protocols for each participant were scored blindly by the experimenter on three separate occasions. The reliability of the scoring was .92. Two criteria were used for both: information

given by the participant that corresponded to (correct statements) and did not correspond to (errors)--the "information units" of the passage. The information units are a breakdown of all sentences into segments or "data units" (each is marked by a "1" and set off by parentheses). A sentence from the Feudalism passage is illustrative. "(The castle¹ was cold) (damp¹) (and generally¹ uncomfortable)." These are considered as three independent segments because they translate into, "The castle was cold," "The castle was damp," and "The castle was generally uncomfortable."

Each participant received 12 scores: six for free recall and six for the short answer questions. The six free recall (FR) scores reflected the two scores given for each content area (there were three in all): one correct statement score (FR+) and one error score (FR-). The six scores for the short answer (SA) questions were broken down in precisely the same manner (SA+, SA-).

Two examples of the scoring system are as follows. For each, an incorrect statement that was written by one of the participants is scored for the number of errors it contains by the use of parentheses and the marker "1." Following that, is the information as it appeared in the passage. Underlinings are used to emphasize the information that was misrepresented in the participant's answer.

(1) Free recall: Feudalism passage

- (a) error: "(popular in the early¹ part of the century),
(the feudal system was used¹ to enhance economic
relations)."

- (b) correct version: Feudalism, the economic system of the European Middle Ages, centered around the exchange of goods and services.
- (2) Free recall: Federal Reserve System passage
- (a) error: The president appoints (14 ¹people) as heads of the Federal Reserve Bank.
- (b) correct version: The power of this vast banking system is in the hands of a seven-member Board of Governors all of whom are appointed by the president of the United States for 14-year terms.
- (3) Short answer: Triangular Trade and Mercantilism passage
- (a) question: What was the difficulty with some of this trade (i.e., colonial trade)?
- (b) error: The difficulty with this trading was (the problem of the constant ¹quest for power) and wealth in the manufacturing and trading of these goods.
- (c) correct answer: Some of the trade was in direct violation of British laws.
- (4) Short answer: Nervous System passage
- (a) question: "Define 'effectors.'"
- (b) error: Effectors help in (the trans¹mission of messages).
- (c) correct answer: Effectors are the organs that respond to the nerve signals.

Summary

The manipulations of two types of materials (diagrams and text) and two methods of presentation (simultaneous or sequential) to determine the effects of these manipulations on the comprehension of three unfamiliar content areas presented in sequence resulted in five experimental groups. Four of these were exposed to the sequential presentation of materials: DD (diagram first then the same diagram again), DT (diagram first then a complementary text), TD (text first then a complementary diagram), and TT (text first then the same text again). The fifth group saw the text and diagram simultaneously (ST). Both short answer and free recall criterion measures were used to assess comprehension. A follow-up questionnaire was used to evaluate the clarity of the directions and preferences for the use of diagrams in reading.

CHAPTER IV

RESULTS

All raw scores were converted to standard scores within content areas (there were three for each participant) within scoring procedures (FR+ FR-, SA+, SA-) for each content area and across all five experimental groups. This was done to help insure compatibility between groups, since the total number of possible correct and incorrect responses was different for each content area.

All results were analyzed using an omnibus F test. The between-subjects factors were Kind of Materials Presented First (diagram or text) (MPF) and Kind of Materials Presented Second (diagram or text) (MPS) or All Experimental Groups (EG). The within-subjects factors were the Familiarity of the Content Areas (FC) or the Sequence of the Content Areas (SC). These were employed in separate analyses. Tukey's Wholly Significant Difference (WSD) was used as the follow-up test for all significant F ratios. All tests were run with an a priori alpha of .05.

The analyses focused on the sequential presentation of materials (a 2 x 2 x 3 Analysis of Variance (ANOVA) comparing the four groups whose materials were sequenced over time; DD, DT, TD, TT) and the sequential versus the simultaneous presentation of materials (a 5 x 3 ANOVA where ST was compared to the other four groups). The between-subjects factors for the 2 x 2 x 3 ANOVA were MPF and MPS and the within-subjects factors were either FC or SC. All analyses were run

within scoring procedures (FR+, FR-, SA+, SA-) for each of the within-subjects factors (FC or SC), bringing the total number of $2 \times 2 \times 3$ analyses to eight. The 5×3 ANOVA's were comprised of five levels of one between-groups factor (EG) and three levels of one of two within-subjects factors (FC or SC).

The presentation of the results will follow the general ordering of the hypothesis. The first major section, Correct Responses, will emphasize the first hypothesis, i.e., that the diagram-text group will record more correct responses than all the other experimental groups regardless of the method of presentation; sequential or simultaneous. The second major section, Errors, will cover the remaining hypotheses: group DT will be associated with significantly fewer errors than the remaining experimental groups, the familiarity of content areas will not be a factor in the results and the recall of correct information will be positively related to the sequence of content areas.

Correct Responses

Correct responses represent the total number of data units recalled correctly for each of the two criterion measures: free recall (FR+) and short answer (SA+).

Sequential presentation of materials. The analysis of correct responses by the $2 \times 2 \times 3$ ANOVA is summarized in Tables 2 and 3. The first hypothesis, i.e., that the DT group would be superior to the other three groups that were exposed to the sequential presentation of materials, was not upheld. Rather, the main effect of MPS

Table 2

Summary of Analysis of Variance for Effects of Materials Before, Materials After, and Sequence of Contents in Free Recall and Short Answer Responses

Source	df	Free Recall				Short Answer			
		Correct		Incorrect		Correct		Incorrect	
		Responses (FR+)		Responses (FR-)		Responses (SA+)		Responses (SA-)	
		MS	F	MS	F	MS	F	MS	F
<u>Between subjects</u>									
A (diagram or text before)	1	205.44	1.67	6.25	.06	250.69	1.68	91.84	.64
B (diagram or text after)	1	1965.44	15.99***	.25	.00	3154.69	21.17***	24.17	.17
AB	1	160.44	1.31	191.36	1.76	196.00	1.32	16.67	.12
Error	44	122.92	--	108.65	--	--	--	--	--
<u>Within subjects</u>									
J (sequence)	2	13.77	.24	59.69	.49	86.13	1.84	277.9	3.68*
AJ	2	18.55	.32	65.44	.49	12.67	.24	23.38	.31
BJ	2	39.59	.68	38.69	.27	8.88	.30	78.05	1.03

Table 2 (continued)

Source	df	Free Recall				Short Answer			
		Correct		Incorrect		Correct		Incorrect	
		Responses (FR+)		Responses (FR-)		Responses (SA+)		Responses (SA-)	
		<u>MS</u>	<u>F</u>	<u>MS</u>	<u>F</u>	<u>MS</u>	<u>F</u>	<u>MS</u>	<u>F</u>
ABJ	2	51.67	.88	275.52	.47	32.80	.97	79.09	1.05
Error	88	58.21	--	111.62	--	39.80	--	75.63	--

*p < .05.

**p < .01.

***p < .001.

2

Table 3

Summary of Analysis of Variance for Effects of Materials Before, Materials After, and Familiarity of Contents on Free Recall and Short Answer Responses

Source	df	Free Recall				Short Answer			
		Correct		Incorrect		Correct		Incorrect	
		Responses (FR+)		Responses (FR-)		Responses (SA+)		Responses (SA-)	
		MS	F	MS	F	MS	F	MS	F
<u>Between subjects</u>									
A (diagram or text before)	1	205.44	1.67	6.25	.06	250.69	1.68	91.84	.63
B (diagram or text after)	1	1965.44	15.99***	.25	.00	3154.69	21.17***	24.17	.17
AB	1	160.44	1.31	191.36	1.76	196.00	1.32	16.67	.12
Error	44	122.92	--	108.65	--	149.04	--	144.57	--
<u>Within subjects</u>									
J (familiarity)	2	6.94	.12	137.80	1.21	49.22	1.29	371.31	5.00**
AJ	2	44.42	.75	117.27	1.03	52.26	1.37	116.51	1.56
BJ	2	12.17	.21	2.90	.03	72.72	1.90	8.51	.12

Table 3 (continued)

Source	df	Free Recall				Short Answer			
		Correct Responses (FR+)		Incorrect Responses (FR-)		Correct Responses (SA+)		Incorrect Responses (SA-)	
		MS	F	MS	F	MS	F	MS	F
ABJ	2	14.63	.25	29.67	.26	41.65	1.09	22.51	.30
Error	88	59.24	--	114.15	--	38.21	--	74.25	--

* $p < .05$.** $p < .01$.*** $p < .001$.

was significant for FR+ and SA+. There was no significant main effect for MPF.

The F ratio for free recall correct responses was $F(1, 44) = 15.99, p < .001$. Seeing the text subsequent to a diagram or a text led to better performance on the criterion measure ($\bar{X} = 53.17$) than seeing the diagram after those same materials ($\bar{X} = 45.72$). There was also a significant main effect for short answer correct responses (SA+), $F(1, 44) = 21.67, p < .001$. Again, text-after was associated with greater numbers of correct answers ($\bar{X} = 53.11$) than diagrams-after ($\bar{X} = 45.72$).

Sequential versus simultaneous presentation of materials. The results of the 5×3 ANOVA led to the refutation of the second hypothesis that the DT group would be superior to each of the other experimental groups regardless of presentation mode (i.e., sequential or simultaneous). A significant main effect of experimental groups was found for FR+ ($F(4, 55) = 4.33, p < .01$) and SA+ ($F(4, 55) = 7.54, p < .01$). The WSDs for FR+ indicated that the TT group (not DT as predicted) recalled significantly more data units ($\bar{X} = 55.36$) than either DD ($\bar{X} = 45.58$) or the TD group ($\bar{X} = 45.58$). There were no significant differences among the DT, TT, or ST groups or between the DD and TD groups. The same general relationships held for short answer correct responses. Both TT ($\bar{X} = 56.19$) and ST ($\bar{X} = 54.17$) made significantly higher scores than either the DD ($\bar{X} = 44.19$) or the TD groups ($\bar{X} = 44.45$). Groups TT, ST, and DT were not significantly different nor were DD and TD reliably different from each other.

Errors

Errors represents the total number of errors in recall in either of the two criterion measures.

The superiority of DT. The hypothesis that the diagram-text group would commit significantly fewer errors than any of the other experimental groups was not supported. There were no significant differences among groups in error responses.

Familiarity of content areas. It was hypothesized that familiarity would not effect performances on the criterion measures. This prediction was disconfirmed. Rather, there was a significant main effect for familiarity of content for the sequential presentation of materials (SPM), $F(2, 88) = 5.00, p < .01$ and for all five experimental groups (EG), $F(2, 110) = 5.97, p < .01$. These results are summarized in Tables 3 and 4. In both cases, the WSD test indicated that significantly more errors were associated with the content areas rated fifth ($\bar{X} = 52.29, \bar{X} = 52.02$, SPM and EG, respectively) and sixth ($\bar{X} = 52.24, \bar{X} = 50.55$, SPM and EG, respectively) than with those that were rated fourth ($\bar{X} = 47.6, \bar{X} = 46.87$, SPM and EG, respectively). In neither case (i.e., SPM or EG), were ratings 5 and 6 significantly different.

Sequence of content areas. The prediction was made that the participants would improve in the recall of information as they passed from the first to the third content areas. This hypothesis was also disconfirmed. There was a significant main effect for the sequence of content for both SPM, $F(2, 88) = 3.68, p < .05$ and EG, $F(2, 110) = 5.75, p < .01$. This data is summarized in Tables 2 and 5. A post hoc comparison of the means for SPM indicated that

Table 4

Summary of the Analysis of Variance for the Effects of Simultaneous and Sequential
Methods of Materials Presentation and the Familiarity of Contents
on Free Recall and Short Answer Responses

Source	df	Free Recall				Short Answer			
		Correct Responses (FR+)		Incorrect Responses (FR-)		Correct Responses (SA+)		Incorrect Responses (SA-)	
		MS	F	MS	F	MS	F	MS	F
<u>Between subjects</u>									
A (all exp. groups)	4	658.88	4.33**	59.50	.58	1070.49	7.54***	213.67	1.63
Error	55	152.20	--	103.02	--	141.92	--	130.99	--
<u>Within subjects</u>									
J (familiarity)	2	3.32	.06	65.74	.62	72.20	1.64	422.41	5.97**
AJ	8	37.80	.66	62.79	.59	55.83	1.27	62.22	.88
Error	110	57.38	--	105.87	--	43.91	--	70.72	--

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 5

Summary of the Analysis of Variance for the Effects of Simultaneous and Sequential
Methods of Materials Presentation and the Sequence of Contents
on Free Recall and Short Answer Responses

Source	df	Free Recall				Short Answer			
		Correct		Incorrect		Correct		Incorrect	
		Responses (FR+)		Responses (FR-)		Responses (SA+)		Responses (SA-)	
		MS	F	MS	F	MS	F	MS	F
<u>Between subjects</u>									
A (all exp. groups)	4	658.88	4.33**	59.50	.58	1070.49	7.54***	213.67	1.63
Error	55	152.20	--	103.02	--	141.92	--	131.00	--
<u>Within subjects</u>									
J (sequence)	2	20.62	.36	90.04	.88	66.60	1.42	413.41	5.75**
AJ	8	28.43	.49	99.36	.97	17.36	.37	48.63	.68
Error	110	57.75	--	102.77	--	46.81	--	71.87	--

*p < .05.

**p < .01.

***p < .001.

significantly fewer errors were made on the first story in sequence ($\bar{X} = 48.04$) than were made on the third story in sequence ($\bar{X} = 52.38$). There were no reliable differences between the first and second or the second and third content areas. For EG, the content areas presented second and third were correlated with significantly more errors ($\bar{X} = 51.02$, $\bar{X} = 51.62$, respectively) than the first content area ($\bar{X} = 46.8$). The former two means were not significantly different.

Summary

In summary, the hypotheses of this thesis were not confirmed. The advance organizer group was not found to be associated with significantly more correct responses than the other experimental groups, nor did the preorganizer group commit fewer errors.

Rather, the only factor to significantly and positively effect the number of correct responses was the material presented second. In particular, when text followed an earlier presentation of diagram or text, scores on the free recall and short answer tests were significantly higher than when a diagram followed an earlier presentation of diagram or text.

When the TT treatment was included in the analyses it was shown that the double text presentation yielded significantly more correct responses than either the DD or TD group on the free recall test and that both the TT and ST groups recalled significantly more information than the diagram-diagram or text-diagram presentations in the short answer criterion measure. None of the analyses indicated significant differences among DT, TT, or ST or between DD and TD.

Also, in all cases involving significant F ratios for the between-subjects factor of experimental groups, the following relationship of correct responses and experimental groups was determined:

DD < TD < DT < ST < TT. Lastly, significant main effects for sequence (i.e., the order of presentation of the stories) and familiarity (i.e., the topic area rated as the least familiar) were found for short answer error responses. Though there were some fluctuations in relationships it was always true that the first story in sequence was associated with significantly fewer errors than the second or third stories in sequence. It was also found that the content area rated number 4 recorded significantly fewer errors than the content areas rated 5 and 6.

CHAPTER V

DISCUSSION

Part A of the first hypothesis predicted that the DT group would recall significantly more data units than all the other groups exposed to the sequential presentation of materials (DD, TD, TT). This prediction was not supported. Rather, text presented subsequently to either diagram or text was the variable that significantly and positively influenced the amount recalled.

A comparison of all five experimental groups disconfirmed Part B of the first hypothesis relative to the superiority in recall of the DT group as opposed to the simultaneous presentation of the same experimental materials (ST). Instead, a very consistent trend across analyses indicated the following ordering of groups as measured by both criterion tests: $DD < TD < DT < ST < TT$ where the TT group consistently evidenced significantly greater recall than the TD and DD groups. There were no significant differences among TT, ST, and DT. Groups DD and TD were not reliably different.

In contradiction to the second hypothesis, the DT group did not commit significantly fewer errors than the other groups. Instead, there was a main effect of familiarity and sequence (disconfirming the third and fourth hypotheses) which in general indicated the most familiar of the three stories (the number 4 rating) or the content area presented first in the sequence of the three content areas was

associated with significantly fewer errors than ratings 5 and 6 or sequences 2 and 3, respectively.

The discussion will emphasize correct responses, errors, and educational implications.

Correct Responses

This section will discuss the superiority of the text-after groups (DT and TT) to the diagram-after groups (DD and TD) and the overall superiority of the TT group in the recall of information from the text.

Text-after versus diagram-after. The DD group was the only one of the sequential groups to conform to expectations. As predicted, this group recalled less information than any of the others. It was explained initially that the DD condition was not only exposed to less information than any of the other experimental groups, but that the criterion tests were directed specifically to the information that was contained in the text.

The number of correct responses recorded by the other groups, however, directly contradicted the hypothesis of the effects of advance organizers. In this instance, the results could indicate that the content and logical structure of the diagrams that were placed before the text did not provide a means of generating the logical relationships of the elements of the text and did not influence the learners' encoding of this information (i.e., they did not act as advance organizers). Rather, text-after, as opposed to diagram-after, facilitated the latter processes, leading to significantly higher recall.

It could also be postulated that diagrams interfered with the processing of text.* That is, diagrams that were seen after the presentation of the text materials (e.g., TD), but before the criterion measure, interfered with the recall of information critical to the completion of the criterion measure (which was directed specifically to the contents of the texts), resulting in superior retention by the text-after groups (e.g., TT). The test performance of the ST group (i.e., the simultaneous presentation of materials) would seem to bolster this contention.

If so, this would seem to confirm (though this will be discussed later in greater detail) the findings of Samuels (1970) and Willows (1974, 1978a, 1978b). It would also indicate, as Mandler and her associates have demonstrated in their studies on picture schemata, that there may be certain characteristics of pictorial (or diagrammatic) organizers that can positively influence or inhibit (in this case, inhibit) the comprehension of the content and the structure of the text. For example, the spatial orientation of information in the organizers was a very prepotent aspect of their construction. Mandler and Ritchey's (1977) finding that pictorial schemata contain little or no information of the general spatial organization of an entire scene may be a possible contributing factor to the predominance of TT over ST, DT, and TD.

A test of the hypothesis of the interference caused by the diagrams used in this experiment would have been a comparison of the existing experimental groups with a text-only control group. If a $TT > T > DT$ progression in the recall of information from the text had been found, confirmatory evidence for the hypothesis would have been

obtained. If not, other hypotheses would have been needed. For example, the progression $TT > DT > T$ would have indicated that diagrams can facilitate the comprehension of text as compared to the text alone, but that the most adequate learning and recall would be achieved by a review of the information to be learned. Other orderings would require other conclusions.

Errors

The following discussion will focus on the significant main effects for familiarity and sequence.

Familiarity. The significantly fewer errors associated with the content area rated 4 relative to the content areas rated 5 and 6 suggests that the participants' familiarity with the content areas had not been controlled for as hypothesized, i.e., they had more knowledge of that one content area than of the other two. This suggests, in turn, that the participants were then able to activate this knowledge to facilitate the encoding of decoding of information that was similar to it in content and structure.

However, this explanation does not account for the relative equality of the amounts of information recalled in the free recall test across all content areas. The requirements of the critical tasks seem to supply part of the answer. It has been demonstrated repeatedly (e.g., Anderson & Pichert, 1978) that higher order units of information are remembered better and recalled better than are lower order units of information. It is suggested that a free recall test is associated primarily with the former, i.e., when participants in an experiment are told to write all they can remember on a particular topic, it is

the higher order units of information that are more accessible in memory and, therefore, recalled more easily. In this case, the nature of the free recall test effectively negated the effects of familiarity. However, a short answer test provides more adequate cues for the retrieval of lower order information, and in this instance, interacted with the greater familiarity of the number 4 passage, accounting for the differential recall of information.

Sequence. The sequence of contents, despite attempts to control for the presentation order of the content areas, via random presentation orders, was confounded with familiarity ($\chi^2 (4) = 15, p < .01$). Ideally, the number 4 content area would have been presented 20 times (a frequency of 33%) in each sequence position (1, 2, and 3). However, in tallying the relationship of frequency to familiarity, the content area rated 4 appeared in the first position 48% of the time, in the second position 20% of the time, and in the third position with a frequency of 38% (this data is presented in Appendix D). This renders the effect of sequence uninterpretable.

Education Implications

In a most general way, the results of this thesis contribute to the existing body of literature (e.g., Samuels, 1970; Willows, 1978a) that indicates that pictures (or diagrams) can distract attention away from the processing of new and novel text materials. Caution is advised with such generalities, however, since the participants (in age and reading ability) and the diagrams utilized in this thesis were very different from the studies cited above. In those studies, the participants were usually much younger (the early elementary grades)

and the pictures were qualitatively different (generally depicting relatively more realistic scenes). The ecological validity of this experiment relative to a college population must also be questioned. Time limits are generally not constrained when reading and/or studying a test.

On a more confident note, this thesis does indicate that educators must become generally more aware of the factors that influence the processing of input and of the demands of various criterion measures in assessing knowledge. The structure of text (higher versus lower order units of information), the differential learning and recall of aspects of that structure (higher order information is usually recalled more readily and accurately than lower order information), and the processing requirements of different critical tasks (e.g., free recall versus short answer tests) are but three of those factors.

Lastly and most importantly, an implication of this thesis is that the media of instruction (e.g., diagram-text combinations) can possibly have a significant influence on the development of knowledge in the individual. This is stated most eloquently by Olson (1970):

Development is the process of elaborating within the limits of his capacity, those conceptual systems evolved by the culture. Thus, we conclude that the demands on the child by the physical and cultural environments (i.e., media) in terms of the differentiation and organization of objects and events determine the structure and elaboration of the child's relevant conceptual systems. (p. 131)

However, to determine specifically how diagram-text combinations as a media of instruction can have a significant influence on the development of knowledge, much more research needs to be done. This research must focus on the interactions among age, reading level, type

of text, type of picture (or diagram), and the reason for reading (among others) before more definitive statements can be made. Only once this has been accomplished can we determine in what situations and with what readers that diagrams are either inhibitory to the processing of text, adjunct to text (nonessential to, though possibly helpful in deciphering text information), or amalgams to text (absolutely essential to the understanding of the text).

Summary

The superiority of text subsequent to either diagram or text as compared to a diagram after a diagram or text is felt to be due to one or two different factors. The first is the insufficient ability of the diagrams-before to influence the accessibility of relevant cognitive structures and enhance the inherent structure of the text, thus facilitating encoding. The second, views the diagrams-after as producing interference in recalling information that is relevant to the completion of the criterial tasks. The second is suggested to provide a majority of the influence.

The main effect of familiarity for short answer error responses was felt to be due to an interaction of the availability of cues for the recall of lower order information and an insufficient ability of the rating form to control for familiarity. It was suggested that the free recall test primarily evaluated the more readily accessible higher concepts of the text passages thus negating the effects of familiarity. Sequence was found to be confounded with familiarity and therefore uninterpretable.

Caution is advised in generalizing the results of this study to either elementary or college-age populations due to the factors of

age and/or the constraints of the experiment itself which produced noticeable differences between the experimental setting and the more usual studying or learning environments. It is felt, however, that the results of this thesis do validly emphasize the need of educators to become more aware of the factors that influence the processing of input and the requirements of the various criterial measures used to assess knowledge.

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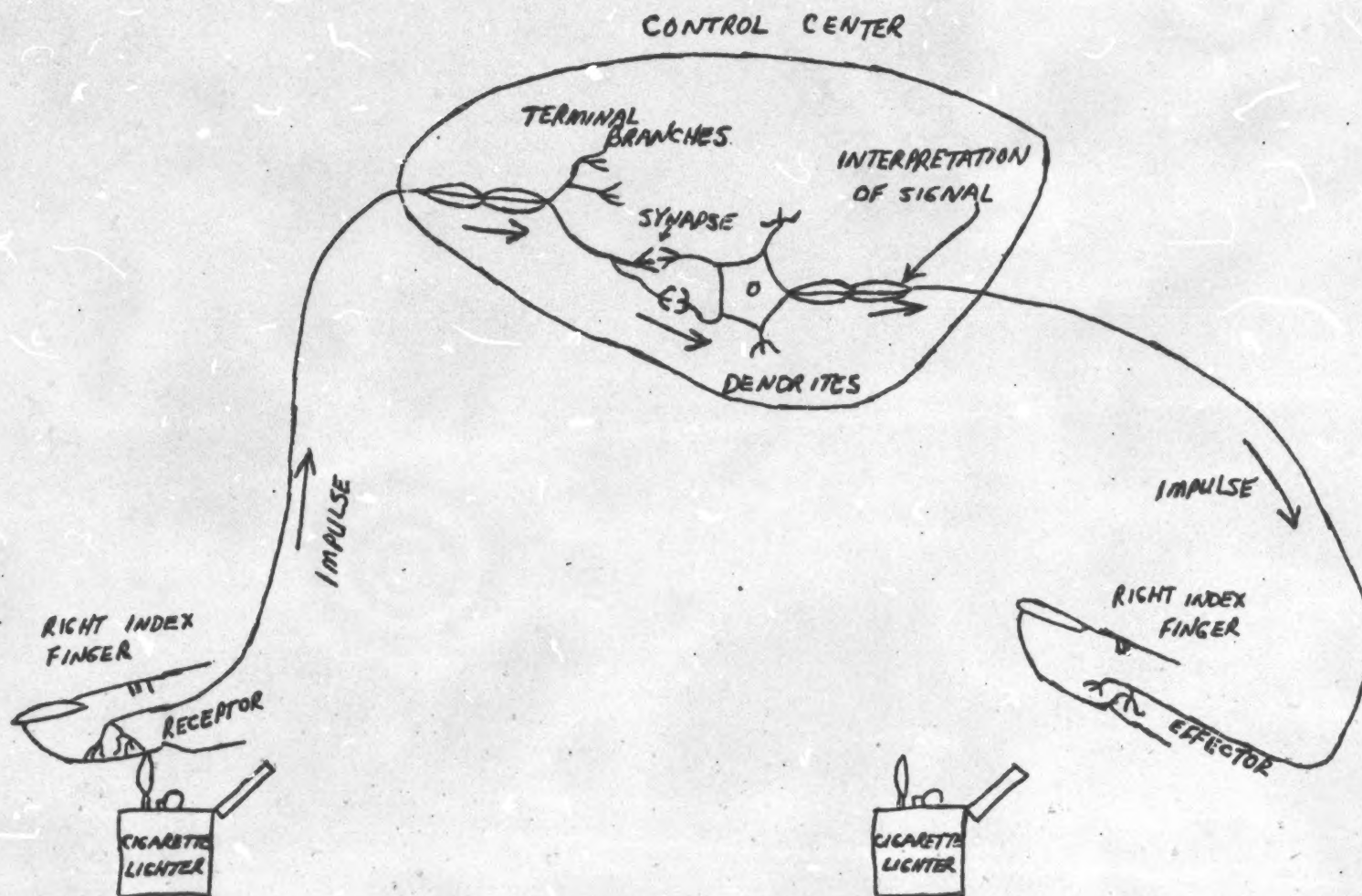
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APPENDIX A
Diagram-Text Pairs

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THE NERVOUS SYSTEM



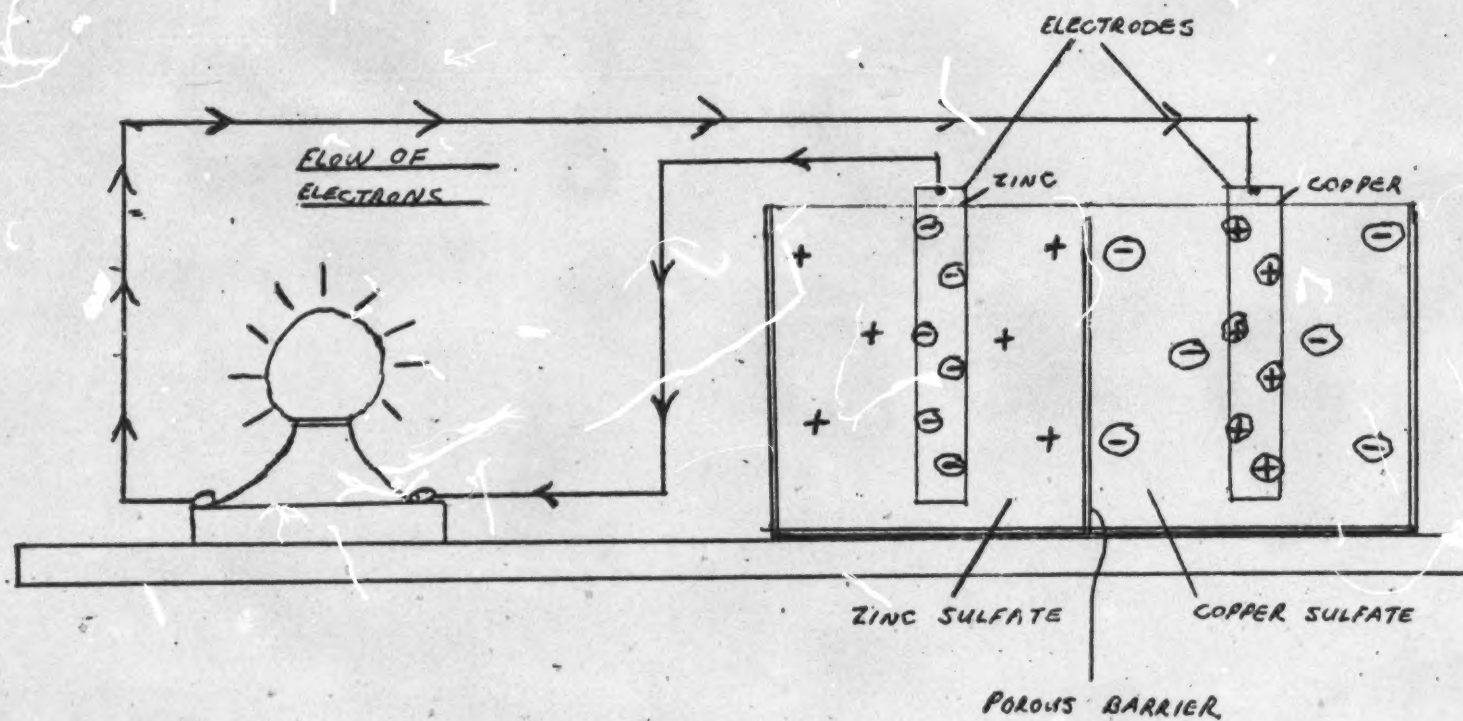
The Nervous System

The nervous system and its billions of neurons are an essential part of the human organism. A simple neuron consists of a cell body (cyton) and numerous cytoplasmic branches called dendrites. Extending from the other side of the cyton is a long myelinated fiber called an axon which has a number of terminal branches or end brushes. The myelinated sheath of the axon helps to protect the internal fibers, prevents short circuiting and in some ways helps speed the impulse along the axon. Once an impulse reaches the end brushes, neurotransmitters facilitate its passage across the gap, or synapse, to the dendrites of the next neuron.

A nerve impulse is an electrochemical signal created by a stimulus which upsets the current electrical or "resting" potential of the neuron. Once the disturbance occurs, changes in potential are transmitted from point to point within a neuron then from neuron to neuron. It is the neurotransmitters which act as stimulants in changing the resting potential of the neuron.

More generally then, sense organs detect changes in the environment and translate these changes into nerve signals which are relayed to a control center that interpret and adjust the signals before sending them on to the effectors or the organs that respond to the stimuli. As an example, if you touch a very hot object you will withdraw your hand very quickly. The receptor that reacts to the heat stimulus is a nerve ending in your skin. The effector is the muscle that responds to pull your finger away.

ENERGY CELL



96

111

112

Energy Cells

All energy cells (e.g., batteries) have essentially the same basic structure. Each cell has two terminals, or electrodes, made of different materials that will react chemically. The electrodes are separated by electrolytes, or mixtures of water and a dissolved substance (though many types of liquids having some moisture content can be used) which makes the water a better conductor of electricity.

Although various types of batteries and dry cells use different materials for electrodes and electrolytes the chemical action is similar to the type described in the following paragraphs.

One type of simple cell contains a zinc electrode on the left and a copper electrode on the right. The copper electrode is placed in a solution of copper sulfate and the zinc electrode is placed in a solution of zinc sulfate. The two solutions are separated by a barrier of porous unglazed porcelain. Since the barrier is porous it allows the solutions to have contact with one another but prevents the solutions from becoming totally mixed.

Chemically, the atoms of the zinc electrode go into the surrounding solution as positively charged zinc ions creating an excess of negative charges. At the copper electrode, positively charged copper ions in solution accept negative charges producing a deficiency of negative charges at that electrode (if the two electrodes are connected to a voltmeter a potential difference of about one volt will be indicated).

When the two electrodes, one positive and one negative, are connected by wire to a bulb, electron flow from the negatively charged zinc electrode to the positively charged copper electrode will cause the bulb to light up.

TRIANGULAR TRADE AND MERCANTILISM

DIRECT TRADE - - - -

DIRECT TRADE - FAVORABLE BALANCE Δ - Δ

DIRECT TRADE - ILLEGAL * - *

A- RAW MATERIALS

B MANUFACTURED GOODS

C GRAIN, FISH, MEAT, LUMBER

D SUGAR, MOLASSES, MONEY

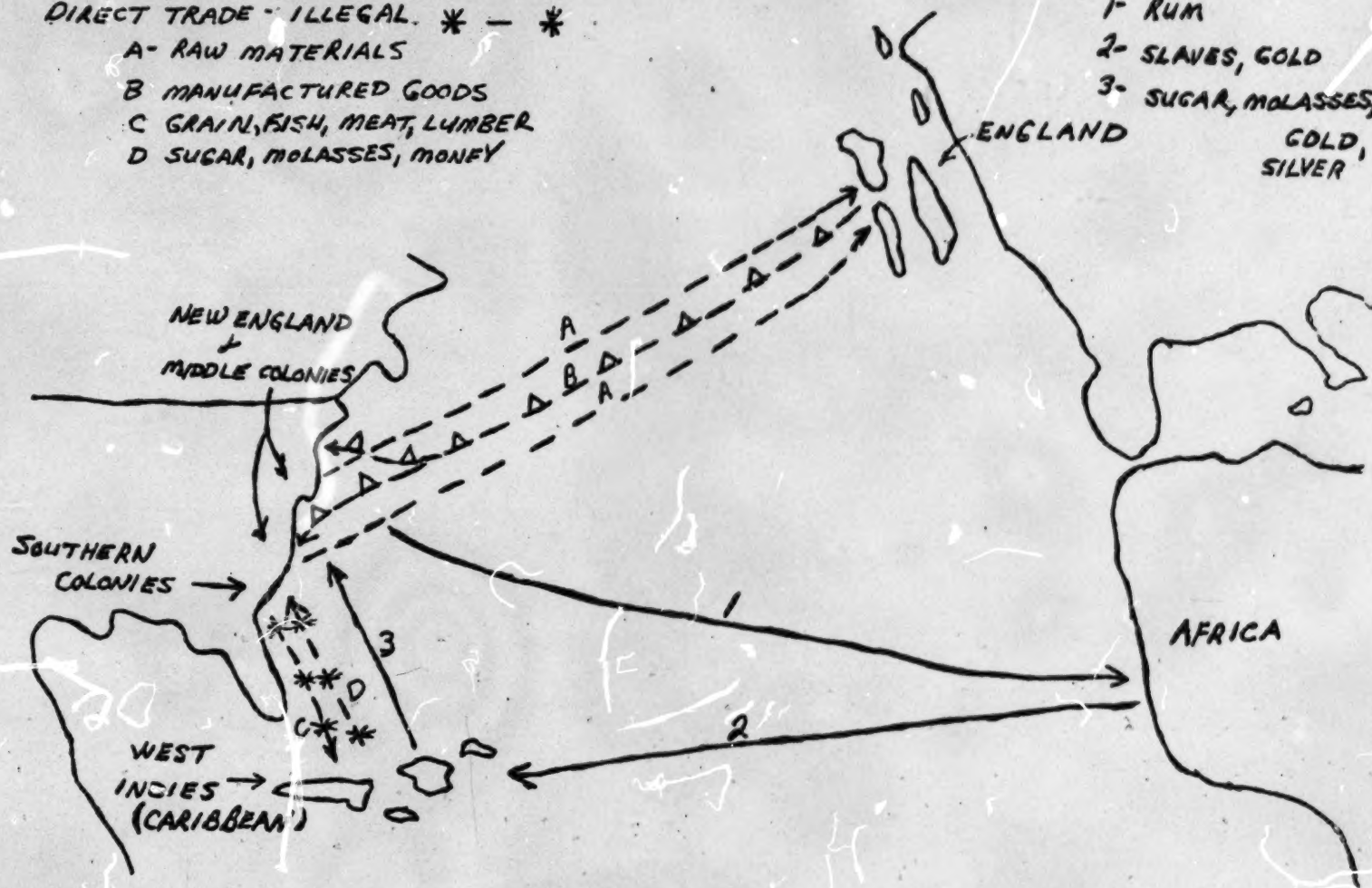
TRIANGULAR TRADE

1- RUM

2- SLAVES, GOLD

3- SUGAR, MOLASSES,

GOLD,
SILVER



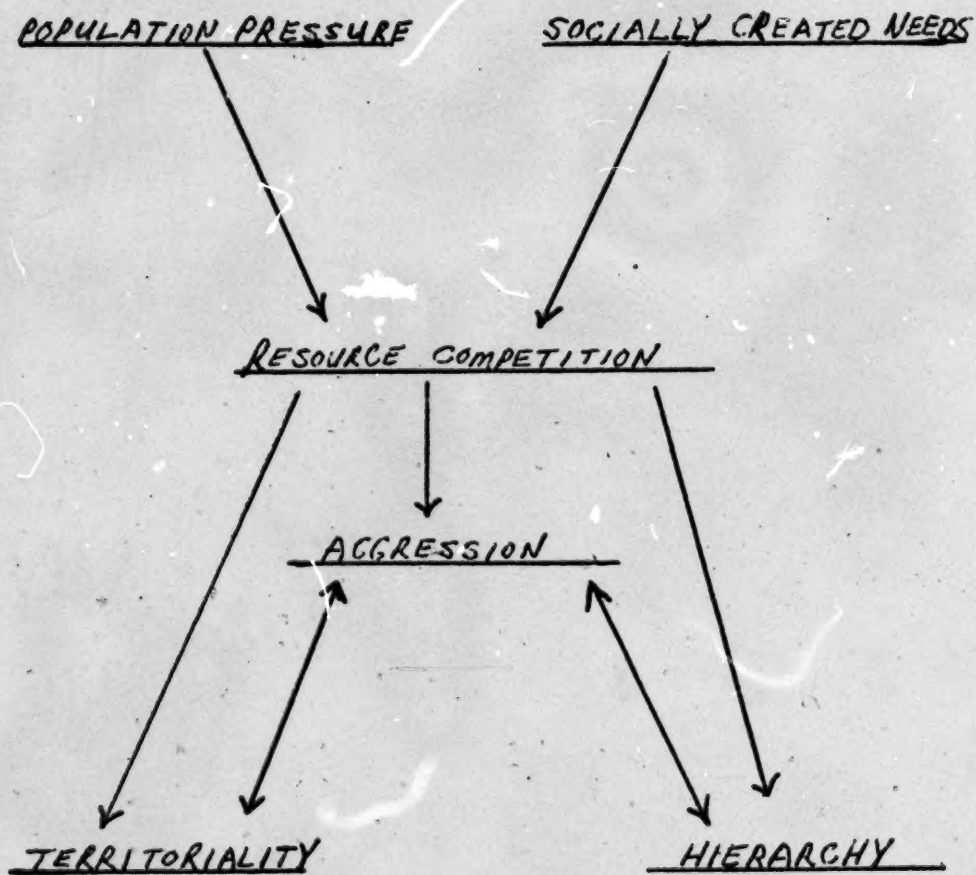
Triangular Trade and Mercantilism

The major source of income for American colonial merchants was triangular trade, a system of trade routes involving Africa, the West Indies, and the Colonies.

Vessels from colonial parts set sail for Africa on the first leg of the journey, their holds laden with rum produced in colonial distilleries. On the west coast of Africa the rum was exchanged for gold and slaves. The vessels then set sail for the West Indies where the human cargo was exchanged for molasses, sugar, or money. The final leg of the triangular trade route brought the traders back to the colonies where the sugar and molasses was used for making more rum with a remaining balance of gold or silver.

Another busy trade route connected the colonies with the Caribbean Islands. Ships from the New England and Middle colonies sailed southward with cloth, soap, meat, grain, fish, unassembled shacks for the slaves, and casks for molasses and sugar. The return trip brought sugar, molasses, and money.

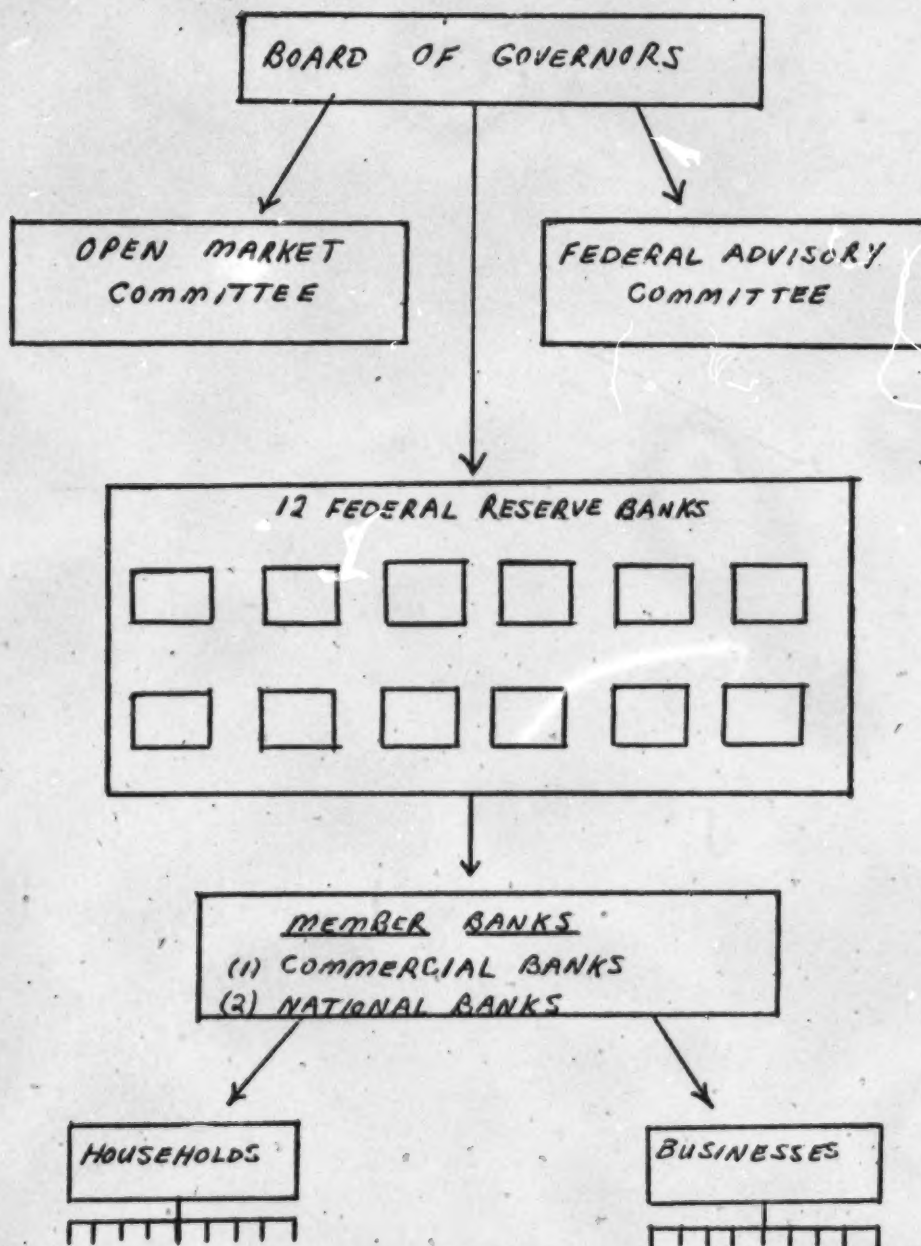
Though most of this trade was perfectly legal some of it was in direct violation of British laws which, in this instance, were an outgrowth of the British policy of mercantilism. Briefly, mercantilism is an economic and political policy whereby a nation tries to gain greater wealth and power than its rivals. This involves building a more powerful army and navy which requires extensive capital. Such capital is generated through the passing of laws which ensure a favorable balance of trade where a country exports more than it imports. Thus a number of laws were passed by the British parliament placing restrictions on members of the colonial empire relative to manufacturing, shipping, selling, and buying.

FACTORS INFLUENCING AGGRESSION

Factors Influencing Aggression

A basic question raised by many is: why is man so aggressive compared to other mammals? The argument put forth by some runs as follows: the basic cause of aggression is competition for resources. There are two basic ways of regulating that competition: territoriality, or establishing some level of control over resources in a given area, and hierarchy, a method of determining a pecking order of access to and the distribution of, resources. Ideally, as long as hierarchies and boundaries are accepted, aggression is inhibited. The paradox is that keen resource competition leads to the development of either territoriality, or hierarchy, or both to prevent a large-scale conflict but, at the same time, the more hierarchy and territoriality there is, the more numerous the occasions for challenge and defense of monopoly and privilege. Thus, it seems that species tend to be aggressive to the extent that they are hierarchial and/or territorial. Population pressure too is correlated with resource competition. Holding the level of resources constant, increased numbers or increased population densities will lead to greater competition and aggression for material resources. Lastly, differential social demands for material resources can significantly intensify any existing conflicts. The within cultural competition for existing oil reserves (e.g., among the U.S. and Germany) and the between cultural conflict involving technology and material resources (e.g., the third-world nations have increasingly demanded western technological expertise in exchange for raw materials) are examples.

Man's competition for resources is greater than that exhibited by most other species because of the fierceness of the competition and the wider range of resources. It seems as though human needs are almost insatiable.

THE FEDERAL RESERVE SYSTEM

The Federal Reserve System

The federal reserve system is unique among the banking systems of the world since it attempts to balance the interests of business and government by promoting stable economic growth. At its inception its primary function was to ensure the adequate supply of currency while today its main concern is the formulation of monetary policy.

The power of this vast banking system is in the hands of a seven-member Board of Governors all of whom are appointed by the President of the United States for 14-year terms. They are assisted by two committees: the Open Market Committee and the Federal Advisory Committee. The former (and the most important) determines the general policies for the sale and purchase of government securities on the open market while the latter assumes an advisory role.

There are 12 separate Federal Reserve banks throughout the nation. Each district bank, run by representatives of the banking and business communities, acts in the interest of its own area. In conjunction with local commercial banks, they hold deposits called "reserves" of the commercial banks, they collect and clear checks, issue paper money in the form of loans to member banks and act as a fiscal agent for the government by handling the financial transactions of the Treasury, among others.

The role of the commercial bank involves holding money deposits, making loans and providing safekeeping functions. The monetary policies of the FRS can be demonstrated directly through the everyday operations of the commercial banks. For example, if an individual deposits \$1,000, the law requires that 15% (\$150) be kept in legal reserve with the remaining \$850 available for loans. Too, the bank is limited in the amount that it can lend relative to the level of "excess reserves" required for that bank.

APPENDIX B

Short Answer Tests

The Nervous System

- (1) What does a simple neuron consist of?
- (2) The myelinated sheath of the axon serves what functions?
- (3) What is the function of the neurotransmitters?
- (4) Define a "nerve impulse."
- (5) Define "sense organs."
- (6) Define "effectors."
- (7) Write a general statement that demonstrates an understanding of the basic functioning of the nervous system.

Energy Cells

- (1) Define the basic structure of any typical energy cell.
- (2) Define "electrolytes."
- (3) One type of simple cell was described specifically. What are the two electrodes made of and what are the surrounding solutions?
- (4) This simple cell contains a barrier. Tell the material it is made of and describe its function.
- (5) Describe the chemical reactions at the zinc electrode.
- (6) Describe the chemical reactions at the copper electrode.
- (7) What happens when the two electrodes are connected?

Factors Influencing Aggression

- (1) What is the basic question?
- (2) What is the basic cause of aggression and how is it regulated?
- (3) Ideally, when is aggression inhibited?
- (4) What is the paradox?
- (5) Explain the effect of population pressure.
- (6) Comment on the social demands for resources.
- (7) Comment on the fierceness of man's competition for resources.

The Federal Reserve System

- (1) Why is the federal reserve system unique among the banking systems of the world?
- (2) What was the function of the federal reserve when it was first established and how has this changed?
- (3) Who controls the federal reserve and how do they attain this position?
- (4) Name the two committees and briefly describe their function.
- (5) Who runs each of the district level federal reserve banks?
- (6) What are the functions of the district level federal reserve banks?
- (7) What is the role of the commercial bank?

Triangular Trade and Mercantilism

- (1) Give a brief definition of triangular trade.
- (2) Describe the first leg of the journey (include information on destination and cargo).
- (3) Describe the remainder of the journey (again, include information on destinations and cargos).
- (4) Describe the other "busy trade route" discussed in the passage (destination and cargos are important here also).
- (5) What was the difficulty with some of this trade?
- (6) Briefly, define the concept of mercantilism.
- (7) What does mercantilism involve?

APPENDIX C

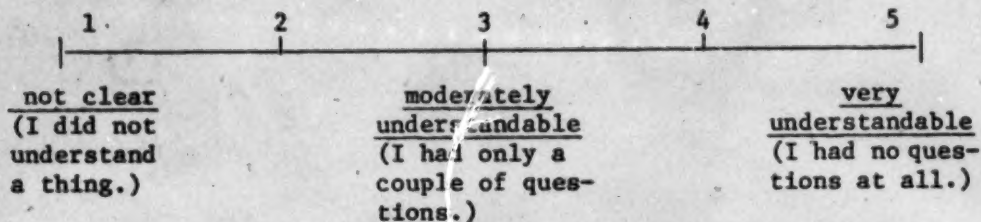
Follow-Up Questionnaire

Please take an extra few minutes to answer the following questionnaire carefully. As the experimenter, I have a number of questions concerning how people learn information. Your thoughtful answers will help me answer these. Be straightforward in your responses. Remember, I wish to discover what you think. Do not try to anticipate what I would like you to say since this information would be useless to me.

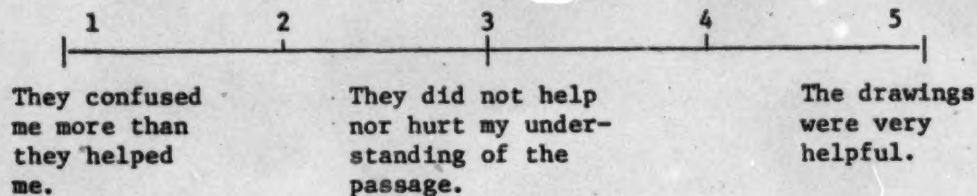
Try to answer all the questions that apply to you by circling, checking, or writing in the appropriate response. If the question does not apply to you, make sure that you indicate that.

Again, thank you for your participation!

- A) Did you find the directions to be clear and understandable?



- B) Were the drawings helpful in understanding the passages?



Does not apply --

- C) If you saw the picture first and read the passage second would you have preferred it the other way around (with the passage first)?

Yes _____ No _____ Does not apply _____

Why? _____

- D) If you read the passage first and saw the picture second would you have preferred it the other way around (the diagrams first)?

Yes _____ No _____ Does not apply _____

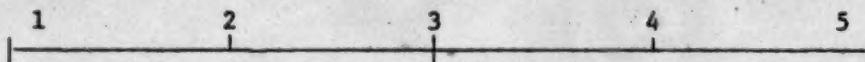
Why? _____

- E) If you saw the passage and the picture at the same time did you:

- 1) concentrate on the passage and look at the picture only
 occasionally to help you understand what you were reading?

- 3) concentrate on the picture and look at the passage only occasionally to help you understand what the picture was trying to say? _____
- 4) concentrate on the picture but refer to the passage frequently to understand what the picture was trying to say? _____
- 5) use both equally? _____
- 6) does not apply _____

F) When you are reading material for your courses do you tend to form mental images, diagrams, or pictures of what you are reading?

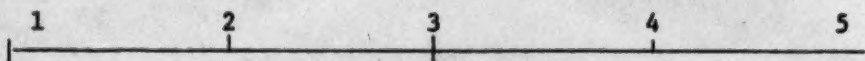


almost never
(It is very rare that I mentally visualize what I am reading about.)

occasionally
(I sometimes visualize what I read about.)

very frequently
(I am constantly visualizing what I am reading about.)

G) Do you ever draw pictures, diagrams, and the like that correspond to what you are reading?



almost never
(It is rare that I will draw a diagram.)

occasionally
(I will sometimes draw a diagram.)

very frequently
(I am constantly drawing diagrams.)

H) If you do form mental images or draw diagrams does it seem to occur at certain times (when reading for pleasure, reading for courses, statistics material, classic literature) more than others?

Yes _____ No _____

Explain _____

- I) Do you think that mental images or visual aids that you have drawn increase your understanding of what you are reading?

1	2	3	4	5

<u>very little</u> (Only rarely do I under- stand some- thing better after I have visualized it.)	<u>moderately so</u> (Occasionally, visu- alizing something helps me to under- stand it better.)	<u>very much so</u> (I very fre- quently find I can under- stand informa- tion better if I can visualize it.)		

- J) Do you think that you are always aware of the mental images that form while you are reading?

Yes _____ No _____

Explain _____

- K) When you are about to begin to read a new textbook, one that is totally unfamiliar to you, do you:

- 1) begin to read the material as assigned? _____
- 2) look in the table of contents and read the introduction to understand the overall plan of the book before beginning to read the assignments? _____
- 3) read small segments of different chapters either to sample the author's writing style or to see how that author feels about certain issues which are of interest to you before reading the assigned material? _____
- 4) generally skim the pages, examining the illustrations and noticing a few chapter headings? _____

APPENDIX D

**The Familiarity of Content Areas and
Their Frequency of Occurrence by
Sequence Position**

Familiarity Ratings

Position in Sequence		4	5	6
	1	29	20	11
	2	12	24	24
	3	19	16	25